University of Pretoria

Readiness Assessment
For Mining Projects

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Degree of confidentiality: None

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DECLARATION

I declare that this field study submitted for the PhD in Project Management at the University of Pretoria is my independent work and that I have not previously presented this work, either as a whole or in part, for a qualification at another university or another faculty of this university.

Hardus Mulder

21 / 01 / 2021

Signed: Hardus Mulder Date

ACKNOWLEDGEMENTS

To my wife, Ansu, thank you for your patience and for all the sacrifices over the last couple of years. I am very grateful for the countless coffees you brought me during this time. Thank you for never giving up and for your gentle encouragements when I needed them.

I would like to acknowledge the many participants in this study. The numerous questionnaires, focus groups, and emails took significant amount of time to complete, and the sacrifice of precious time is truly appreciated.

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Lastly, I would like to thank Dr Giel Bekker and Mr. Mike Murray for their inputs, patience, and guidance over the last couple of years.

ABSTRACT

The front–end planning phase of a project potentially has the biggest impact on the outcome of the implementation phase. Globally, significant research has been conducted into the relationship between the quality of front–end planning and the success of the implementation phase of a project. Several tools have been developed to assess the level of readiness of a project study to proceed into detail design and implementation. However, no such commonly available tool existed for mining projects. The available assessment tools are either generic, not specific to mining projects and therefore do not include many of the elements which are critical to mining projects, or the property of consulting firms.

In order to create an Assessment Tool for Mining Project front–end planning, the first step was to evaluate the mining industry and identify all of the elements which should be addressed during a mining project study. This was done through a literature review (which included existing front–end planning evaluation tools), as well as focus groups and surveys. The result was a list of 180 elements which should be considered during a mining project study. To incorporate a metric structure for quantitative evaluation, the Project Definition Readiness Index (PDRI) format as utilized by the Construction Industry Institute (CII) was used. This resulted in the 180 elements being divided into four sections and 18 categories.

Since not all elements contributed equally to project success, weights were assigned to each element. The weighting process involved asking experienced mining project professionals to assign weights to each element. After the data were reviewed and adjusted for normality, a weighted list of elements was created which would comprise the Readiness Assessment Tool (RAT) for mining projects. The weighting also provided a quantitative assessment value, based on which a decision can be made about whether or not to proceed to the next project phase.

To validate the instrument, the completed RAT for Mining Projects was tested against completed projects. The validation process indicated that there was a significant correlation between the RAT score of a project, and the eventual implementation success. The validation process also highlighted some dominant

performance indicators that could influence project results.

The performance indicator relating to the *performance of the completed project against expectations* was found to have the most significant correlation with the RAT score and accounted for 39% of the variability. This was closely followed by the *impact of change orders*, which had the second–highest correlation to the RAT score (36.2%). Similarly, 8% of the variability in *Cost Performance* and 7.9% of the variability in *Schedule Performance* could be explained by the RAT score. The RAT score can explain 3.02% of the variability in the *Operating Score* of a project and 3.86% of the variability in the *Customer Score*.

By creating a comprehensive, weighted list of elements to be addressed during the front–end phase of a mining project, the RAT for mining projects can assist project team members in coming to a common understanding of the areas which need to be studied, as well as the relative importance of the various elements. The most significant contribution of this study is that project teams can use the RAT as a self–assessment tool during any stage of the project study and identify the areas of the study which require more definition. Teams can also use the RAT to calculate an overall RAT rating at any stage, which will indicate the overall level of readiness to proceed into the next phase of the project.

Through assessing the completeness of each of the 180 elements to determine a single RAT score, the RAT can assist project members, as well as decision–makers such as Boards of Directors, to make informed decisions regarding the approval of projects.

Finally, depending on the accuracy and reliability of input data, the RAT should improve the probability of a successful project.

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LIST OF ABBREVIATIONS

APRA	Advanced Planning Risk Analysis
AusAID	Australian Agency for International Development
CIDA	Canadian International Development Agency
CPI	Capital Productivity Improvement
ConSERV	Concurrent Simultaneous Engineering Resource View
CII	Construction Industry Institute
EBITDA	Earnings before interest, taxes, depreciation, and amortization
EPCM	Engineering / Procurement / Construction and Management consultants
ESKOM	Electricity Supply Commission
BODx	expanded basis of design
FDI	Foreign Direct Investment
FEL	Front–end loading (planning) in projects
SFD	Fuzzy stochastic dominance model
IPA	Independent Project Analysis
ICMM	International Council on Mining and Metals
LOM	Life of Mine
MTPA	million ton per annum
MARP	Mining and rehabilitation program
MMR	Mixed Method Research
NASA	The National Aeronautics and Space Administration
NPV	Net Present Value
O and M	Operations and maintenance
OBIA	Organisational based information architecture
PWC	Price Waterhouse Cooper
PDRI	Project Definition Rating Indexes
PMBOK	Project Management Body of Knowledge
QRA	Quantitative Risk Assessment
RAT	Readiness Assessment Tool
ROA	Real Options Analysis
SPPS	Single–Period Project Selection
SLO	Social Licence to Operate
TxDOT	Texas Department of Transport
EC	The European Commission
JICA	The Japan International Cooperation Agency
USAID	The United States Agency for International Development
VIP	Value Improving Practices
WBS	Work break down structure

1. INTRODUCTION

1.1 Background

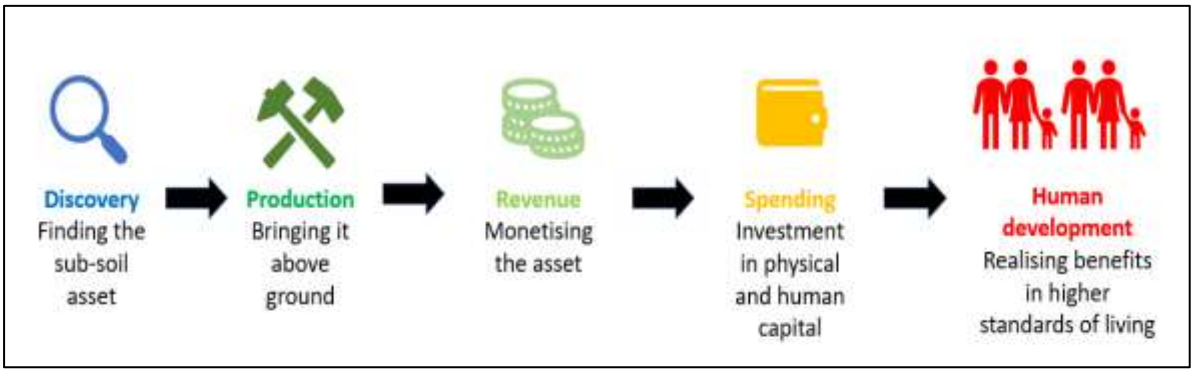
The mining industry plays an essential role in the global economy. It contributes approximately 11.5% to global GDP. When the mining service industry (which includes construction, fuel, and fertiliser production) is included, the total contribution to the global GDP is 45% (Creamer, 2012:3). The contribution of mining in low– and middle–income countries towards foreign direct investment, exports, government revenue, gross domestic production and employment are depicted in Table 1.1.

Table 1.1 – 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)

Figure 1.1 depicts how countries can transform ore deposits into sustainable value.



Source: ICMM (2018:30)

Figure 1.1 – Asset transformation from ore to development

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 (Accenture, 2012). According to Muldowney (2015:1), project spending will reach between US$ 6 trillion and US$ 9 trillion per year by 2030. Despite the significant role of 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, Quelhas, Filho, Franca and Meirino, 2014:402). Since 1965, overruns with regards to costs have averaged between 20% and 60% in mining projects and projects which are currently underway are projected to exceed their original budgets by at least 25 – 30% on average. (Mining Markets, 2014).

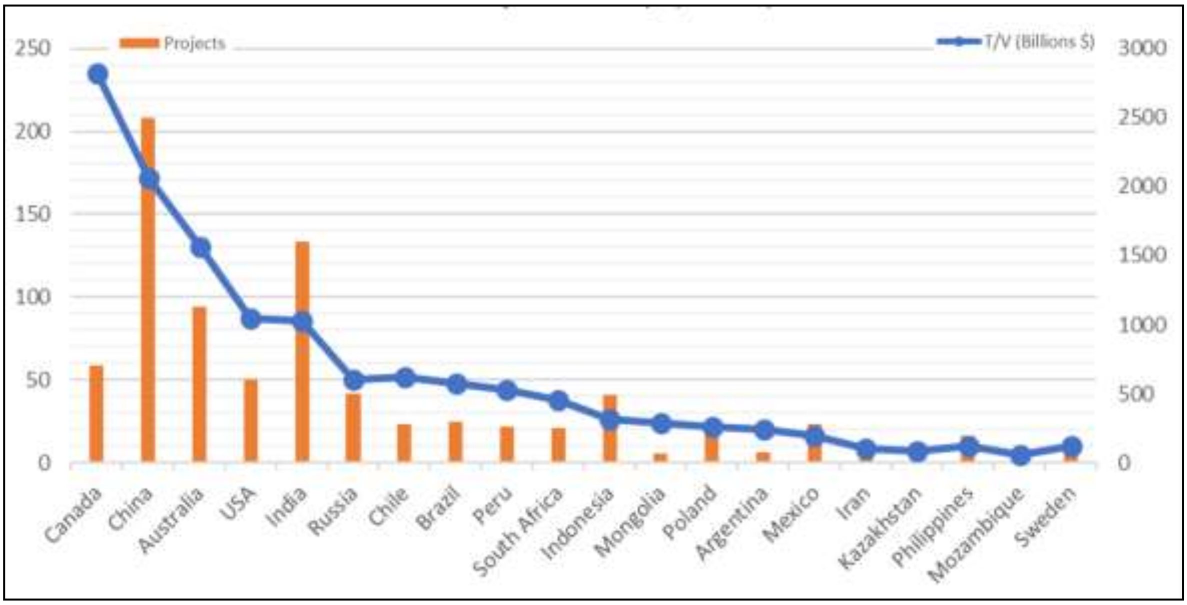
Table 1.2 indicates the locations and estimated values of mining projects globally, as at the end of 2017.

Table 1.2 – Global mining projects in December 2017

	Global Mining project Development (U.S. $ Billion)			
	Exploration	**Study & engineering**	**Construction**	**Total**
Europe	13,3	53,3	9,5	76,1
Turkey & Stans	2,4	17	3,9	23,3
East Asia	6,3	107,3	76,8	190,4
Russia	10,9	31,2	12,7	54,8
South East Asia	8,5	31,1	8,2	47,8
Oceania	1,4	90,3	7,2	98,9
South Asia	0	74,6	4	78,6
Middle East	0,1	18	4,1	22,2
Africa	16,5	100,2	14,4	131,1
Latin America	12,8	152,2	32,9	197,9
U.S. & Canada	87,7	198,9	28,3	314,9
				1,236

Source: Govreau (2018:24)

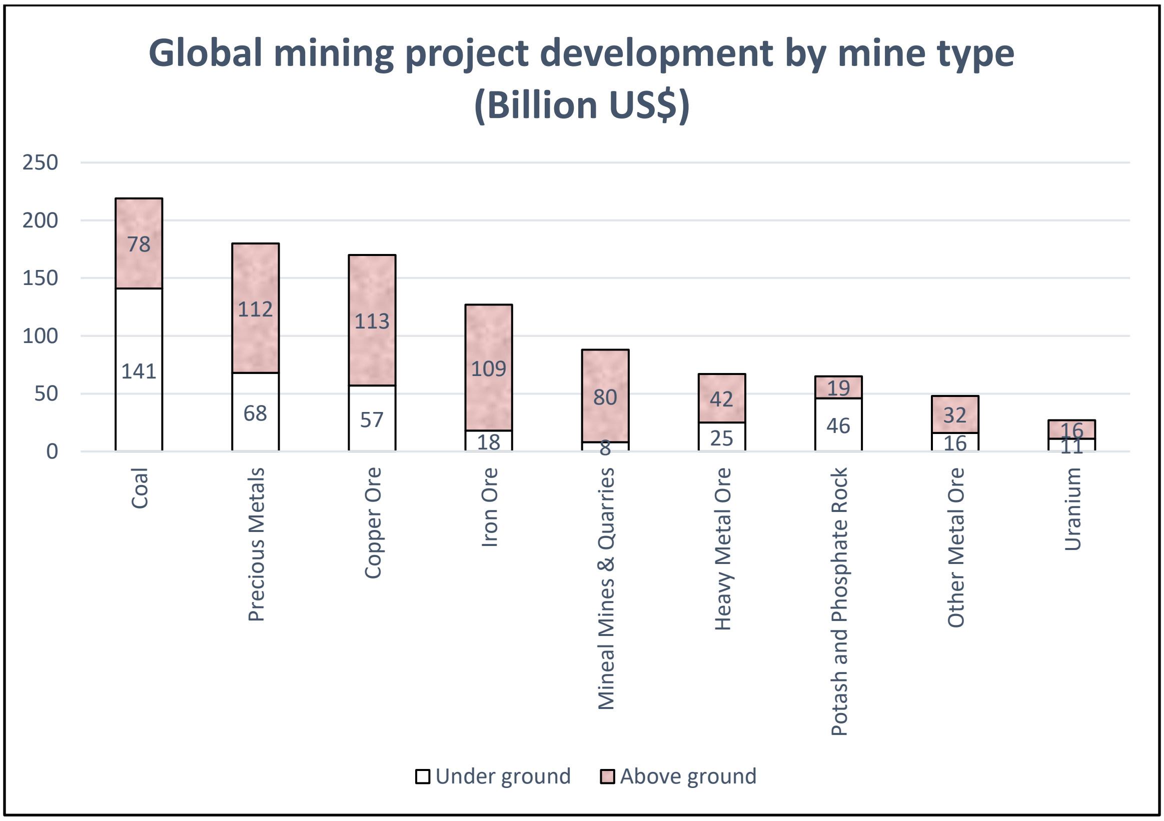
A typical mining project not only adds value during the operation of the mine but also during the exploration, construction, closure, and post–closure periods. Figure 1.2 indicates the location of the top 20 countries for mining projects in 2018, along with the value and number of projects in these countries.



Source: Govreau (2018:25)

Figure 1.2 – Top 20 countries for mining development

Figure 1.3 depicts global mining projects underway at the beginning of 2018, based on the type of mine (aboveground or underground.)



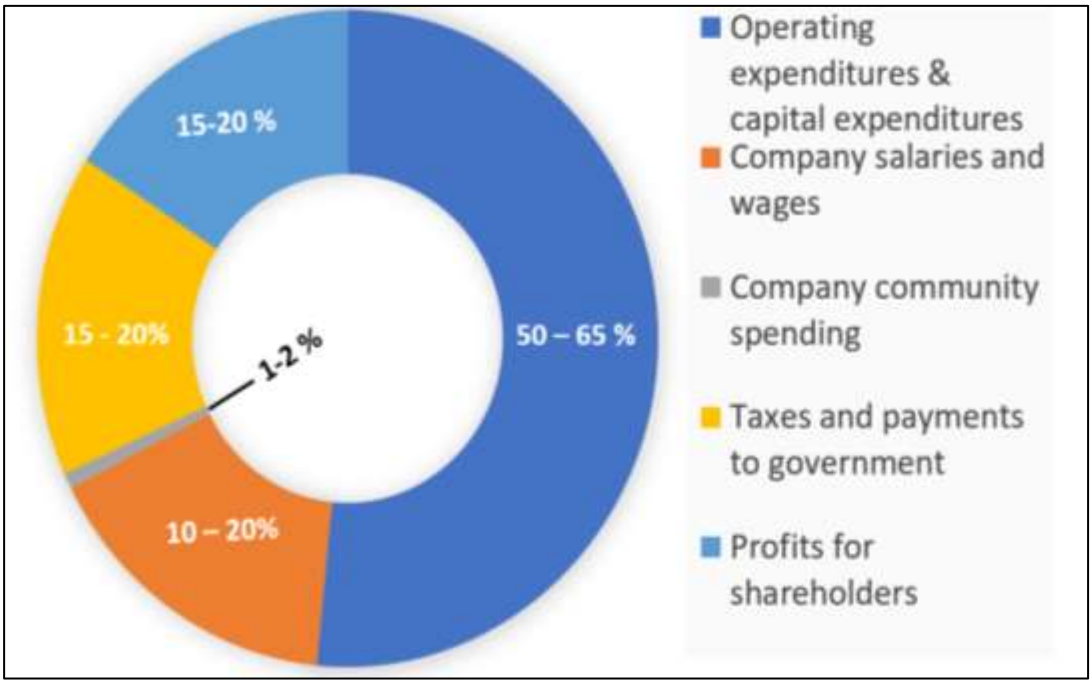
Source: Govreau (2018:26)

Figure 1.3 – Mining projects by mine type

A study by Ernst and Young (2015:4) found that global mining and metals capital expenditure on projects between 2012 and 2015 ranged between US$ 98 billion and US$ 142 billion. When mining projects are executed, the revenue is usually distributed among four stakeholder groups (ICMM: 2018:31). These are:

- Suppliers (who provide inputs into the process);
- Employees (who provide the labour component);
- Government (who receives royalties, taxes, and profit sharing); and
- Investors (who receives profit).

The typical division of revenues in mining projects is depicted in Figure 1.4.



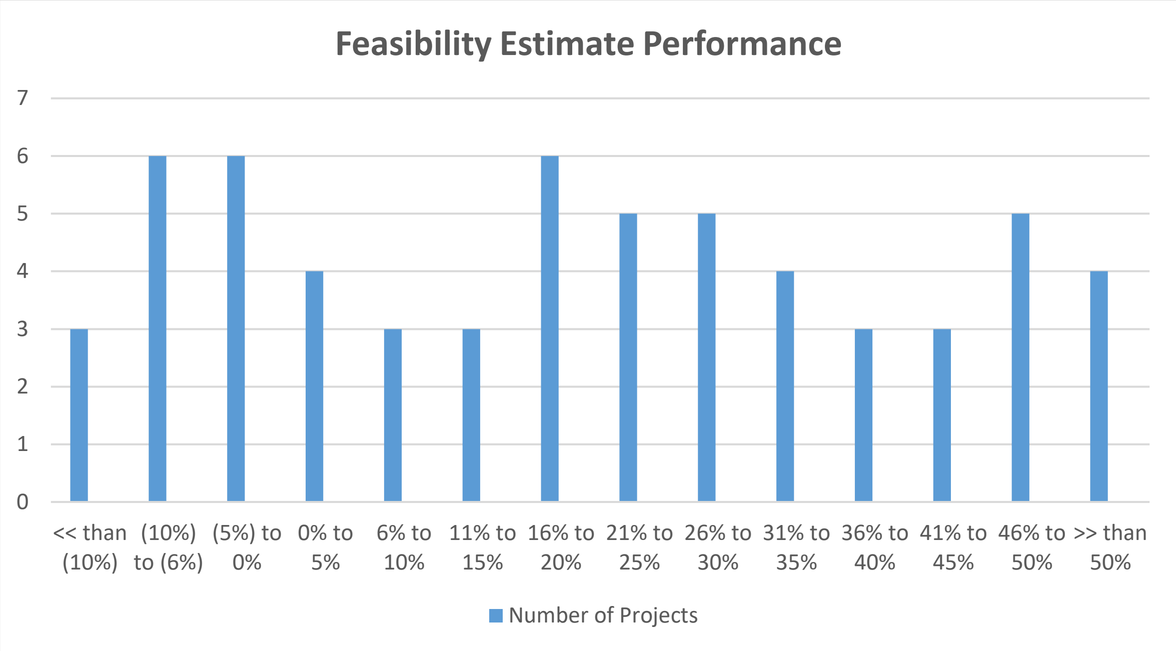
Source: ICMM (2018:31)

Figure 1.4 – Revenue allocated to stakeholder groups in a typical mine

In low– and middle–income countries, mining accounts for a significant portion of foreign direct investment, exports, government income, gross domestic production, and employment.

Gypton (2002:40), in a study which compared 60 mining projects where new mines were constructed, found an average cost overrun of 22% compared to the approved budget. Almost half of the projects had cost overruns of 20% or more. Figure 1.5

indicates the breakdown of cost overruns.



Source: Gypton (2002: 40)

Figure 1.5 – Breakdown of the mining project cost overrun / underrun

A study conducted in 2005 found that only 2.5% of large capital projects in the mining industry could be described as successful when evaluated based on scope, cost, schedule, and business benefits (Motta, Quelhas, Filho, Franca and Meirino, 2014:402). Papke–Shields and Boyer Wright (2017:172) note that, although projects are becoming more successful, there are still a substantial number of projects which do not meet their goals and expectations. Mining Markets (2014:1) notes that since 1965 overruns with regards to cost have averaged between 20% and 60% in mining projects. Projects currently underway in the mining industry are projected to exceed their original budgets by at least 25 – 35% on average. Carter, Gillespie, and Gilbert (2009:2) found that large capital projects can destroy significant shareholder value.

The mining industry offers some unique challenges as far as projects are concerned. Accenture (2012) found that the scale and complexity of mining projects (which are often multi–billion–dollar investments) often lead to budget and schedule overruns. Some of the factors affecting mining projects, mentioned by Accenture (2012), include:

- Infrastructure needs, such as roads, railways, pipelines, ports, and electricity in less developed countries;
- Lack of talent and skilled workers; and
- Environmental and regulatory requirements.

Accenture (2012) found that, after the availability of talent and unconsidered regulatory requirements, insufficient detail during the planning stage was the third most significant contributor to project delays.

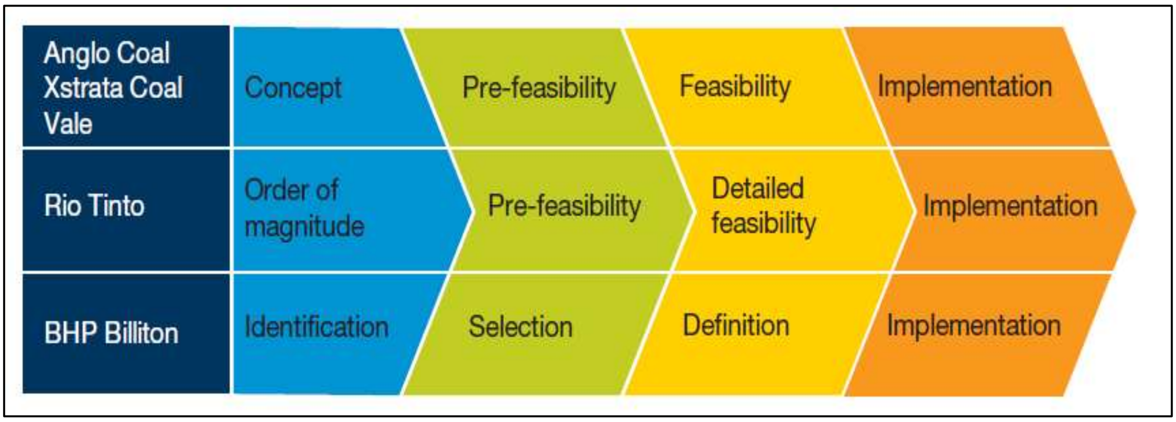
Brahm and Tarziján (2015:1854) mention some characteristics of mining projects, which distinguish them from projects in other industries. Projects can be divided into two distinct groups, namely Brownfields projects (projects which expand or add new facilities, and are located at the same site as the main project) and Greenfields projects (new projects on undeveloped land which do not interact with current mining operations). Brownfields projects are generally more complex than Greenfields projects, due to the interaction with existing plant and operations. Mining projects are usually divided into a "development stage" and an "implementation stage". During the "development stage" the concept and basic design of the project are addressed. Detail design and construction occur in the implementation stage.

Due to the high capital costs associated with mining projects, as well as the higher than average risks associated with these projects, mining companies conduct assurance reviews on projects before they get approval to proceed with detail engineering and construction. The outcomes of these assessments can be subjective and difficult to understand for non–technical decision–makers (Chapman, Ward and Harwood, (2006:109). Ireland (2008: 40) advocates the use of a stage–gate process in mining project studies, as this can assist with managing uncertainties and risk. A stage–gate is essentially a gate at the end of each phase of a project study. At any of the stage–gates, external gatekeepers should have the ability to kill the project if the ore body is found to be less promising than anticipated, or if the hurdle rate is not achieved due to changes in demand, prices or interest rates. Ireland (2018:40) notes the following benefits associated with a stage–gate approach in mining projects:

- Discipline is ensured during the decision–making process, as well as the study process;
- The implementation is of a better quality;
- Risks are better understood and managed;
- Decision making is based on facts;
- It provides a structure for idea generation;
- It allows for end–user collaboration in the earlier stages of a project; and
- A more transparent process for users.

Ireland (2018:40) adds that the stage–gate process ensures the systematic build–up of information, enables better control of the development process, and minimises the risk of failure or project abandonment. Steffen, Couchman and Gillespie (2008:2) add that mining companies must have proper frameworks in place to evaluate and prioritise their projects. Projects must be assessed in a structured manner to ensure that investment decisions are made on sound financial, environmental, sustainable development and social principles. Steffen et al. (2008:4) also note that the quality of decision making in the early stages of project evaluation is critical for ensuring an optimal project outcome. The ability to influence the outcome deteriorates as the study progress, while the cost of changes increases dramatically throughout each project evaluation stage. Steffen et al. (2008:3) highlights the importance of being able to compare various options in a project, using a standard framework.

The terminology used by some of the larger mining companies to define the various phases of a project is depicted in Figure 1.6.



Source: Steffen et al. (2008:3)

Figure 1.6 – Stage–gate terminology used by larger mining companies

In this section, the importance of mining projects was discussed, along with the performance of mining projects. Some of the unique characteristics of mining projects were also highlighted. In the next section the front–end planning phase of projects will be discussed, to highlight the importance of conducting a thorough front–end study, and the contribution that this could have in enhancing project performance. A tool for evaluating the level of definition achieved during this stage will also be introduced.

Gypton (2002:41) found no correlation between the size and experience of the mining company which undertook the project implementation and the scale of the cost overrun, which means that mining projects are at risk, irrespective of the company maturity. Gypton (2002:41) also could not find a significant correlation between the overrun and the location of the project. Gypton (2002:41) mentions that disappointing due diligence is a contributing factor to the overruns. Shortcomings in the feasibility study of the projects need to be identified. Gypton (2002:41) mentions several factors that impact the quality of a mining project study. These are:

- Limited resources, which includes capital and qualified personnel. Committing too many resources to an uneconomic project is noted as being counterproductive.
- Limited time, due to the pressure to produce the study as quickly as possible, often lead to clashes with board meetings or meetings with investors.

- The inability to compare projects due to the highly site–specific nature of mining projects.
- The cyclical nature of mining.
- The very long project development timelines.
- Limited experience with mining companies to develop projects.
- The lack of experienced project and engineering personnel, due to a high turnover of staff, which runs together with the cyclical nature of the mining industry.
- Very few design engineers and project practitioners have been involved in the entire lifecycle of a project study, which means that they lack the "big picture" view. The ability to assess the risks and shortcoming in the project study is thus limited.

Gypton (2002:43) concludes that a feasibility study becomes a mere financial evaluation, based on a technical investigation.

Even though the historical, and current performance of mining projects have been poor, the reasons or causes for this has not been thoroughly researched. However, since mining projects are by nature large capital investments , it can be argued that similar reasons or causes, resulting in poor performance in other large capital project sectors, may apply.

According to Collins, Parrish and Gibson (2015:1), the front–end planning phase of a project has the highest potential impact on reducing risk and ensuring project success. These arguments are further supported by Gibson, Kaczmarowski and Lore (1993:2). Efforts during this phase of a project have the highest potential returns in ensuring project success during the later stages. Williams and Samset (2010:41–42) found that projects with adequate front–end loading have been shown to have an 80% success rate, while those with insufficient planning had success rates of only around 20%.

Assessing and measuring the level of Scope Definition of a mining project study is complex. 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 (Williams and Samset, 2010:40). There is a real possibility that different parties may interpret information differently in the absence of a standard appraisal tool (Williams and Samset, 2010:39).

Due to the high cost of mining projects and the substandard performance of these projects, the need was identified to develop a standard assessment tool to evaluate the state of a mining project study. Although there are many assessment tools, most of these tools are either generic (not specific to mining projects), or not freely available to the industry (held by consulting firms).

1.2 Project selection

Cooper (2014:27) highlights a significant problem faced by decision–makers when having to decide where to spend capital. The complexity associated with selecting the appropriate project to implement is highlighted by Cooper (2014:27), along with the need for the appropriate diagnostic tools and pricing models, to assist in making the best decision regarding the allocation of capital to projects. Cooper (2017:28) notes that transparency and "science analysis" should guide infrastructure investment decisions, and that diagnostic tools should be used to assist in making the best decisions. The World Bank (Williams and Samset, 2010:40) refers to the concept of ensuring that only projects which have been thoroughly studied, are approved for implementation, as "Quality–at–entry". Samanta (2017:110) maintains that a multi–criteria decision model for mining projects is essential.

Some of the questions which should be asked during a project appraisal, according to The Institute of Directors (2015:5), are:

- What are the significant risks which remain in the project, and
- how could this affect the project's progress?

An effective assessment tool based on the correct decision criteria could assist in answering these questions and enabling the board to make effective decisions.

Ireland (2008:39) notes that in mining projects, the initial expenditure, before the mining venture delivers revenue, is significant. Therefore, there is a need to proceed as quickly as possible into operations, to ensure that the high upfront costs can be recovered. It is therefore important to ensure that the project study duration is optimal. The relative low cost of planning upfront is highlighted by Ireland (2008:39), who compares it with the substantial cost of rectifying oversights or mistakes at a later stage. Ireland (2008:39) notes that the cost of rectifying mistakes at a later stage can be up to a million times more than the cost of correcting these mistakes during the project study. Ireland (2008:40) also highlights the possibility of shortening the construction period to ensure earlier returns on the investment, if planning is done correctly during the study phase of a mining project.

Flyvbjerg, Garbuio and Lovallo (2009:173) propose that decision–makers adopt an outside view which considers the broader context of the project, including other similar projects, when evaluating projects, instead of taking an irrational, biased inside view, which could easily lead to overestimating returns and underestimating costs. Flyvbjerg et al. (2009:185) strongly recommend detailed assessments and criticism of projects before approval, through expert and independent peer reviews, to create more transparency and better decision making. Williams and Samset (2010:47) state that, to prevent “analysis paralysis”, decision–makers need to make decisions on project approval on a specific set of facts. Being bombarded with too much information regarding a project will prevent executives from establishing a broad overall perspective, which is necessary for objective decision–making. Finding the right balance between too much information (which will prevent decision–makers from making objective decisions), and too little information (which can lead to negative impacts on cost, time and reputation during implementation), is imperative, as is finding a mechanism to facilitate the unbiased evaluation of the project study.

In this section the importance of selecting the correct project to proceed into implementation, was discussed. The importance of a fit for purpose Readiness Assessment Tool was also introduced. In the next section, the mining industry as well as mining projects will be explored, to highlight the importance of the industry. The scale and performance of mining projects will thus be explored.

1.3 Mining projects

A study by Ernst and Young (2015:4) found that global mining and metals capital expenditure on projects between 2012 and 2015 were between US$ 98 billion and US$ 142 billion. When mining projects are executed, the revenue is usually distributed among four stakeholder groups (ICMM: 2018:31). These are:

- Suppliers (who provide inputs into the process);
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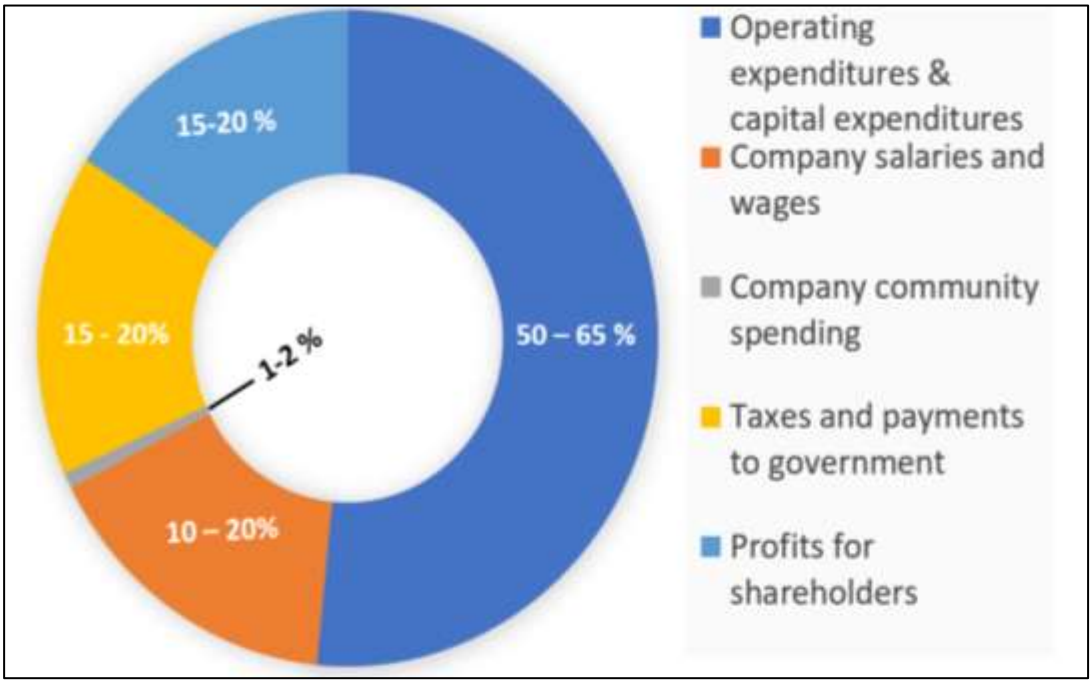
- Government (who receives royalties, taxes, and profit sharing); and
- Investors (who receive profit)

The typical division of revenues in mining projects is depicted in Figure 1.7.



Source: ICMM (2018:31)

Figure 1.7 – Revenue allocated to stakeholder groups in a typical mine

In low– and middle–income countries, mining accounts for a significant portion of foreign direct investment, exports, government income, gross domestic production, and employment.

In section 1.1, 1.2 and 1.3, the importance of conducting front–end loading in project studies was highlighted. The size and complexity of mining projects, along with some of the unique characteristics of mining projects were explored. The need for a tool to assess the level of Scope Definition of a mining project was also explored. The next section looks at the problem which this study seeks to address.

1.4 Problem statement

The main problem to be addressed during this study is:
No general, objective project definition and readiness criteria exist for mining projects.

1.5 Motivation

Jamasmie (2012:1) notes that in an interview with 31 executives looking after global mining projects, only a third stated that they stayed within 25% of the approved budget, and fewer than 20% stated that they completed projects within 10% of the approved budget. Insufficient details during the study of the project were blamed by 42% of respondents as the reason for these overruns.

There are numerous examples of mining projects which have failed, at least in part because of shortcomings which may have been identified if a RAT for Mining Projects existed and was used before project approval. One such project is the Mayoko Project of Exxaro resources (Exxaro, 2014). This project was terminated after ZAR 5,8 billion was sunk into the project. According to Exxaro's website (Exxaro, 2014), this was in part due to higher than anticipated project development costs. From the record of events which led up to the stoppage of the project, it is apparent that Exxaro changed some of the critical Scope Definition elements after proceeding with the implementation phase of the project. These scope changes included initially starting to develop a two million ton per annum (MTPA) mine, but later opting to evaluate a 12 MTPA mine. This project is a prime example of some of the risks associated with mining projects, which could lead to poor decision making if the study of the project is not adequately mature when the decision is made to proceed with implementation. Some of the other reasons for the eventual termination of the project included the delays in concluding rail and port agreements with the Republic of Congo, as well as the rapid decline in iron ore prices (from $168 / ton on average in 2011 to $55 / ton on average in 2015), which affected the business case of the project (Statista, 2018).

Koven (2015) mention the Phoenix project of Rubicon Minerals Corp. in Canada, which started producing gold in June 2015. By October 2015, the company reported that it had milling problems and had spent significantly more than was anticipated. In November 2015 production was halted, as the geology was not as expected. The share price of the company fell from a high of US$ 6 per share to 16 cents. Koven (2015) states that Rubicon rushed the project into construction and skipped essential steps along the way. It proceeded straight from the preliminary economic assessment stage (which is based on preliminary estimates) into construction, without conducting a proper pre–feasibility or feasibility study. Some of the assumptions regarding production costs were unrealistic and should have been picked up if an independent review had been conducted before approval. The assumed production cost for the project was US$150 per ton for mining and processing, while the nearby Goldcorp Inc. mine had costs of US$268 per ton.

Colossus Minerals Inc. is another mining company which according to Koven (2015) proceeded into construction on a gold mining project in Brazil, without a detailed feasibility study. The project failed to reach production.

Arnold (2014) mentions the Sino Iron mine of Citic Pacific, which cost US$ 10 billion to develop, as an example of a mining project that did not perform as expected. The project ended up costing four times the original budget and lost hundreds of millions of dollars in its first year of production. Amongst the blunders Citic made, was the assumption that it could use Chinese labour at Chinese pay levels in Australia, as well as incorrect assumptions regarding currency trends. Smith (2018) notes that Citic booked more than US$ 5 billion of write–downs and impairments between 2014 and 2018 and that the company is involved in legal disputes regarding royalties which could cost it as much as 2.7 billion Australian Dollars.

Ireland (2008), mentions two more mining projects which failed due to projects being rushed into implementation, without adequate studies. The OK Tedi mine in Papa New Guinea was approved for implementation before the environmental constraints were adequately considered and addressed, with the assumption that these would be addressed in parallel, while the project was being executed. The Century mining project in Queensland, Australia, was also approved while specific critical issues were not yet addressed. These included only securing a market for half of the product, as well as not addressing the social environment of the project, which led to clashes with the local inhabitants.

Santos, Ferreira and Penna (2017:3) state that during the construction of the Minas Rio project in Brazil, the affected population were not given fair chance to participate in the licencing process, and that environmental norms were “bent”, to allow for the operation of the venture. In April 2018, Anglo American, the owner of the mine and pipeline to the coast, announced that it was suspending the operation of its Minas–Rio iron ore operation, as two leaks were discovered in the pipeline which carried iron ore, in slurry form, to the export terminal (Anglo American:2018). The suspension was ordered so that the entire length of the pipeline could be examined. At the time it was foreseen that this would take 90 days and would result in a reduction of between US$ 300 and US$400 million in earnings for Anglo American. A four–kilometre section of the pipeline would have to be replaced. Mark Cutifani, CEO of Anglo American, was noted as stating that this stoppage would affect 35% of the employees at Minas Rio who would be on extended leave.

The Pascua–Lama mine project, being constructed by Barrick, was stopped by regulators, and later permanently closed, due partly to various breaches of environmental regulations. The company was also fined US$ 11.5 million. After the regulator stopped the project in 2013, Barrick shelved the project due to significant cost overruns and falling commodity prices (Mining.com, 2018).

Fraiberg and Bryce (2012) note many mining projects that had problems regarding the economic assessment of the projects. The Cerro Morro project of Extorro Gold Mines used inferred mineral resources to justify the project. It was a very weak estimate of the true extent of the mineral body, which should have been firmed up by a more detailed study of the ore body, before approval of the project. This lack of details regarding the ore body extent led to a dispute with the Canadian government, which ultimately prevented the project from being completed.

The Mes Aynak copper mine project in Afghanistan is another example of a failed mining project (DW.com: 2013). The China Metallurgical Group Corporation paid US$ 3,5 billion for extraction rights. However, the project has not progressed due to several reasons. The security around the mine is cited as one of the reasons, along with the presence of several Buddhist temples which are 1500 years old, and which must first be secured before construction can continue. The lack of infrastructure, which would have to be constructed to mine the deposit, is also mentioned as a contributing factor to the current situation. The payment of “protection money” to the Taliban is another contributing factor to the delays in implementing the project.

Edwards (2017:1) uses the example of the Oyu Tolgoi mine in Mongolia to highlight the significant impact which incomplete consultation with local communities can have on a mining project. Due to a complaint by local tribes, the project had to make several concessions to the local communities, to continue with construction. These including constructing new wells and maintaining existing ones and developing a pasture management plan. The mining company also had to review its compensation plan to local herders and include more herders. Also, it had to invest more money in local development by developing a local market, constructing a slaughterhouse, and introducing a fodder planting program. In addition, the mining group had to introduce a scholarship program and help improve local health services. Edwards (2017:1) highlights the value of involving communities in the early phases of a mining project and transparent communication. The importance of a robust dispute resolution mechanism is also stressed.

Holley and Mitcham (2016:19) note that the Pebble deposit, despite being one of the largest known deposits of gold and copper in the world, was never mined by the owner and that one of the partners pulled out of the joint venture which was studying this project. The main reasons for the decision not to proceed was the fact that the Social Licence to Operate (SLO) was not received, as the local stakeholders were against the establishment of a mine in the salmon–rich fishing area. The public participation phase of the project study indicated that the indigenous people, residents, and international pressure groups were all against the construction of a mine in the area. The geological study also indicated that the area was prone to earthquakes, which could have led to the leakage of acidic and metal–rich water into the nearby salmon habitat. Holley and Mitcham (2016:26) state that it is essential for mining companies to conduct public participation processes, and to achieve not only environmental authorisation before constructing projects but also the Social Licence to Operate. They hold that the decision not to proceed with a project, if found to be opposed by the local inhabitants, may lead to increased reputational capital expenditure for the mining company elsewhere. By conducting a thorough study, the joint venture was able to prevent the construction of a project which may very well have been severely affected by environmental and social issues.

1.6 Research question

The primary research question in this study is:

- What criteria should be considered and included in a project definition and Readiness Assessment Tool for Mining Projects?

Secondary research questions include:

- Are there existing assessment tools available in other industry sectors that can be used as a learning platform to develop a specific tool for mining?
- What metrics can be developed or adopted to calculate a quantitative value indicative of project readiness?

1.7 Objectives

The objectives of this study are:

1. To study the mining industry, to identify commonalities and divergences from other industries as it relates to projects.
2. To determine which factors, influence project success in mining projects, especially during the front–end planning phase.
3. To develop a Readiness Assessment tool for projects in the mining industry that will improve project definition and eventual success.

1.8 Delineations and Limitations

The study focused on projects within the mining industry. To ensure that the findings of the study applied to the mining industry in general, participants from various countries where significant mining activities take place were included in the study. The study looked specifically at large Greenfields or large Brownfields projects, and as such, the findings are not necessarily applicable to smaller projects.

1.9 Propositions

Proposition and hypothesis both refer to the formulation of a potential answer to a scientific problem. While a hypothesis must be both measurable and testable, a proposition deals with concepts for which a laboratory test is not available. Therefore, the potential answers to the research problem in this study are addressed using propositions, instead of a hypothesis. There are two propositions in this study. The first deals with developing a fixed and definite list of variables to be measured during Scope Definition, while the second deals with the RAT score as a measure of the level of Scope Definition, and its correlation with the performance of the project during implementation.

Proposition 1 – A fixed and definite list of variables related to the Scope Definition of mining projects can be developed.

This proposition was tested by producing the draft tool and sharing this with various experts. Their feedback was incorporated into the list of Scope Definition elements.

Proposition 2 – The Readiness Assessment score indicates the current level of Scope Definition and corresponds to project performance.

This proposition was tested through the validation or testing process of the Readiness Assessment on actual projects.

1.10 Chapter Overview

The following paragraph provides an overview of the content of the various chapters of this report.

Chapter 1 – Introduction

In this chapter, the background of the study was provided. Background information was provided on the importance of project selection and the size and importance of mining projects. The research problem was described, along with the motivation for the study. The research questions and objectives were explained, and the limitations of the study highlighted. The research propositions were also stated.

Chapter 2 – Survey of the Related Literature

In this chapter, the literature was reviewed. The chapter was subdivided to cover mega projects, front–end planning in projects, important considerations in projects, and Project Scope Definition. The literature was also evaluated to cover he determination of a project status and other Readiness Assessment tools. Mining projects were also evaluated based on the literature.

Chapter 3 – Conceptual model

In this chapter, the conceptual model is explained, along with the background to the conceptual model.

Chapter 4 – Research Methodology

In this chapter, the research paradigm, along with ontology and epistemology, is considered. The mixed–method research (MMR) strategy is discussed, along with the design of an MMR study. The research methodology used during this study is defined. This research built on the methodology developed by the CII in compiling the four existing PDRIs. A mixed–method approach was followed. Qualitative methods (literature review, interviews, a focus group, and email correspondence) was used to compile an unweighted RAT check sheet, and then quantitative methods (surveys) were used to weight and validate the RAT. The details of this methodology are discussed in chapter four.

Chapter 5 – Discussion of outcomes of the study

In this chapter, the outcome of the study is discussed. This outcome includes findings relating to the weighted RAT for mining tool, as well as the analysis of the validation process, where the completed tool was tested for validity against completed projects.

Chapter 6 –Conclusions and Recommendations

In this chapter, a summary of the research results is given, along with suggestions for further studies in the field. The novel contribution of this study is explained in this chapter. Conclusions and recommendations have been included in this chapter.

In this chapter, the background to the study was given. The difficulty faced by decision makers in the mining industry when deciding on which projects are approved to proceed into the implementation phase, was examined. The complexity and differentiating factors of mining projects were also investigated, and the problem which this study seeks to address, was scrutinized. The Motivation for the study, along with the objectives and Research Questions were highlighted. All of this served to introduce the study, and to lay the foundation for the rest of the study.

In Chapter 2, the appropriate literature will be reviewed. This is to examine the importance of the front–end planning phase of a project, and highlight the role which the work done during this phase, plays in determining the outcome of the implementation phase. In the literature review, the various tools which exist to assist in assessing the readiness of a project to proceed into the implementation phase, are also explored. The differentiating factors in mining projects are discussed, to indicate the need for a unique Readiness Assessment tool for the industry.

2. SURVEY OF RELEVANT LITERATURE

In the previous chapter, the main research problem, as well as the research questions, were highlighted. The objective of this chapter is to collate and study relevant literature on large or mega project failures, the reasons for failure, and mitigation actions taken to prevent or limit poor project performance through the development and implementation of project Readiness Assessment tools. The specific focus will be on the design and content of assessment tools. This is done by examining the benefits of front–end planning in projects and how it should be addressed. The importance of Scope Definition, as well as the process of determining the status of a project, is discussed. The specific characteristics of mining projects are reviewed, and the chapter concludes with the proposed theoretical structure, as well as components and elements to be considered when developing a project Readiness Assessment Tool for mining projects.

2.1 Megaproject performance

When evaluating mining projects, it is important to look at the performance of megaprojects and to take the learnings from megaprojects into consideration, since most mining projects fall into this category of projects. In the following paragraphs, the definition of megaprojects will be explored and investigated, and this will be followed by an exploration of the reasons for megaproject failure. Lastly the importance of front–end planning in megaprojects will be explored.

2.1.1 Defining Megaprojects

Flyvbjerg (2014:6) notes that megaprojects are typically valued at more than US$ 1 billion, take longer to develop, and can impact millions of people. These projects typically involve many stakeholders and are more complex than other projects. Muldowney (2015:1) notes that projects costing more than US$ 100 billion are not uncommon and that in 2012 there were more than 100 projects in Australia with a value of more than $1 billion.

Van Marrewijk, Clegg, Pitsis and Veenswij (2008:601) add that complex construction projects resemble megaprojects, as they are executed by integrated project organisations which not only build but also operate the facilities. Prieto (2015:38) adds that the study and approval of these projects take longer than standard projects, and often require more stringent environmental approvals, more stakeholder interactions, and more stringent stage–gate reviews before project approval. Rezvani and Khosravi (2018:115) note several distinguishing characteristics of large projects. They are executed by multiple joint organisations, have large scopes, timelines, and budgets, and have high degrees of uncertainties. Large projects are also more susceptible to external influences due to their accountability to numerous communities and governments. Flyvbjerg (2014:7) points out that megaprojects are getting bigger as time goes by, and that the size of infrastructure projects has grown by between 1.5% and 2.5% per year over the last century. This means that megaprojects are getting between two and three times bigger each century.

Flyvbjerg (2014:6) mentions that the megaproject approach is increasingly being used as the preferred method to execute projects in the mining industry (among others).

2.1.2 Performance of megaprojects

Flyvbjerg (2014:7) notes that if a megaproject “goes wrong” this can have a very negative impact on a company or even a nation. Nevin (2015) mentions the Medupi power station project in South Africa, which in 2007 was meant to be completed in 2015 at a cost of R80 billion. In 2015 the completion date and cost were updated to 2019 and R105 billion. The latest estimates indicate that the real cost of the power station will be close to R200 billion when it is finally completed.

Table 2.1 indicates some of the megaproject “blowouts” which Flyvbjerg (2014:11) refers to in his studies.

Table 2.1 – Mega–projects which have experienced significant cost overruns

Megaproject blowouts	
Project	**Cost Overrun %**
Suez Canal, Egypt	1900
Scottish Parliament Building, Scotland	1600
Sydney Opera House, Australia	1400
Montreal Summer Olympics, Canada	1300
Concorde supersonic jet, UK / France	1100
Troy and Greenfield Railroad, US	900
Excalibur Smart Projectile, US / Sweden	650
Canadian Firearms Registry, Canada	590
Lake Placid Winter Olympics, US	560
Medical transaction system, US	560
Bank of Norway headquarters, Norway	440
Furka Base Tunnel, Switzerland	300
Verrazano–Narrows Bridge, US	280
Boston's Big Dig Artery / Tunnel project, US	220
Denver International Airport, US	200
Panama Canal, Panama	200
Minneapolis Hiawatha light rail line, US	190
Humber Bridge, UK	180
Dublin Port Tunnel, Ireland	160
Montreal Metro Laval extension, Canada	160
Copenhagen Metro, Denmark	150
Boston–New York–Washington Railway, US	130
Great Belt Rail Tunnel, Denmark	120
London Limehouse Road Tunnel, UK	110
Brooklyn Bridge, US	100
Shinkansen Joetsu high–speed rail line, Japan	100
Channel Tunnel, UK / France	80
Karlsruhe – Bretten light rail, Germany	80
London Jubilee Line extension, UK	80
Bangkok Metro, Thailand	70
Mexico City Metro line, Mexico	60
High–Speed Rail Line South, The Netherlands	60
Great Belt East Bridge, Denmark	50

Muldowney (2015:1) refers to the construction of the channel tunnel between Europe and Britain as an example of a megaproject which nearly bankrupted the parent company. The National Broadband Network rollout in Australia is another megaproject mentioned by Muldowney (2015:1) which overran significantly on cost, and which was partly responsible for the election of a new government, with a mandate to control the project. The construction of the Sydney Opera House is also mentioned by Muldowney (2015:4) as a megaproject which not only took much longer and cost much more to build than anticipated, but which ended up ruining the reputation of the architect and costing the state premier an election. The project ended with a 1 400 % cost overrun and took ten years longer to complete than anticipated, even when some of the scope elements were removed to cut costs.

2.1.3 Reasons for megaproject failure

Muldowney (2015:5) notes that megaproject problems often originate when upfront planning and requirements definitions are not done. Muldowney (2015:6) blames backers of projects, who over–commit too early to a project. Muldowney (2015:6) notes that excessive scope changes are common in megaprojects. The A$ 3 billion Murrin Murrin nickel mine project in Western Australia is mentioned as an example of a project where excessive scope changes, delays and technical problems resulted in a five–year legal battle, and the removal of the CEO (Kerr, 2015:1; Muldowney, 2015:1

Flyvbjerg, Bruzelius, and Rothengatter (2003:117) mention that, due to the potential impact of a megaproject, project selection should be done by informed decision–makers. The decision–makers should accurately assess the likelihood of success, and ensure that the economic, social, and environmental impacts are addressed. Flyvbjerg (2014:8) states that information regarding cost, schedules, benefits and risks are often not accurately utilised in the assessment of projects, which leads to incorrect decision making, and in turn results in cost overruns, delays and benefit shortfalls.

Muldowney (2015:1) advocates educating decision–makers to understand that simply approving a project approval at any cost 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 (2016:273) maintain that the ability to select the most beneficial project should be among a project organisation’s top strategic capabilities and that a proper set of assurance tools is critical. Winch and Leiringer (2016:276) advocate 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 et al. (2009:179) introduce 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”. Parties with a vested interest in approving the project may deceive the decision–makers Flyvbjerg et al. (2009). They have information that the decision–makers do not have. Flyvbjerg et al. (2009:180) 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, to assure project approval. Williams and Samset (2010:47) add that humans are not always rational decision–makers, but prone to making the wrong decision, especially if faced with incomplete information. Williams and Samset (2010) also mention that project sponsors often fail to consider the outcome of a project study objectively. , They look at the project from an ”evolutionary perspective”. Humans are prone to succumbing to such bias when there is not tool for evaluating the project study outcome on a rational basis.

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

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

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

Van Marrewijk et al. (2008:598) hold that the organisational design of a project, as well as the form of contract and implementation 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 (2011:58) compare 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). Landoni and Corti (2011:59) found that all the agencies have some form of project appraisal before approval. The AusAID project cycle focusses on the detail design which must be undertaken before approval, while the CIDA project cycle focusses on the feasibility of the project, to ensure that the project is viable and sustainable. The EC model considers the relevance, feasibility, and 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.

Eriksson and Kadefors (2017:493) state that large and complex projects have many unique characteristics, but that there is a need to institutionalise routines and organisational designs on an industry level, to ensure effective communication and decision making. They blame over–reliance on heuristics (sometimes called biases) in a project organisation for weak organisational practices, and state that there is a need for mechanisms at a higher organisational level to mitigate risks and enable learning from a wide range of projects. They propose pre–designed organising elements, such as routines, organisational models, and guidelines, and monitoring and adapting them over time and between projects.

Walker, Davis, and Stevenson (2017:184) state that project delivery estimates include a contingency (cost and time) to account for anticipated risks and uncertainties. They classify these risks and uncertainties as either known and anticipated risk, or unknown risks and ambiguous potential outcomes. Project owners can account for risk based on known and evaluated risks together with an allowance for general uncertainty relating to unknown risks. The portion of risk relating to known and evaluated risks can be better understood if subjected to a measuring tool, which identifies and ranks the level of the remaining risk. Walker, Davis and Stevenson (2017:187) advocate for the creation of a consensus decision–making tool, which promotes communication and a shared system, for addressing risks in projects.

Flyvbjerg et al. (2002:286) found that business cases, cost–benefit analysis and social and environmental impact assessments are often incomplete. Van Marrewijk et al. (2008:591) add that many elements contribute to the underestimation of project costs before approval. These include setting contingencies too low and not accounting for potential scope changes during implementation. Flyvbjerg, Garbuio and Lovallo (2009:172) add risk of scope changes, high complexity and unexpected geological features to the list of reasons why project costs are underestimated. Prieto (2015:26) mentions that factors which are generally considered as fixed in shorter projects, become variable in projects with longer durations.

Steffen et al. (2008:4) state that projects can often be approved based on the support of a single, subjective sponsor with the necessary authority or budget within an organisation. A standardised approach to investment evaluation is required to compare projects on an equal basis while ensuring that the strategic fit of a project and the risk appetite of the company is considered. Nevin (2015) concludes that humans tend to be self–obsessed, believing that they have absolute certainty when making decisions. Steffen et al. (2008:5) propose the use of project evaluation as a way of ensuring that projects are compared effectively. Pinto and Patanakul (2015:1181) note that although the support of a project sponsor or champion is important in securing resources and approval, sponsors may have personal motives for supporting specific projects, and risk tolerance and self–enrichment potential play a role when project sponsors decide on which project to support. Sponsors may also be attracted to innovative or novel projects as this could be viewed as having the potential to enhance their careers. Sponsors could also continue supporting a project which is not viable due to elevated self–worth. It is therefore essential to have an unbiased method of evaluating projects before approval.

2.2 Front–end planning (FEP) in projects

Williams and Samset (2010:40) note that the term "front–end phase" or "front–end planning" (before detail design and implementation), is not unambiguously defined and that various other terms are used, depending on the organisation and industry. Other terms for this phase of a project include "feasibility analysis", "front–end loading" or "conceptual planning" (George et al., 2008:66).

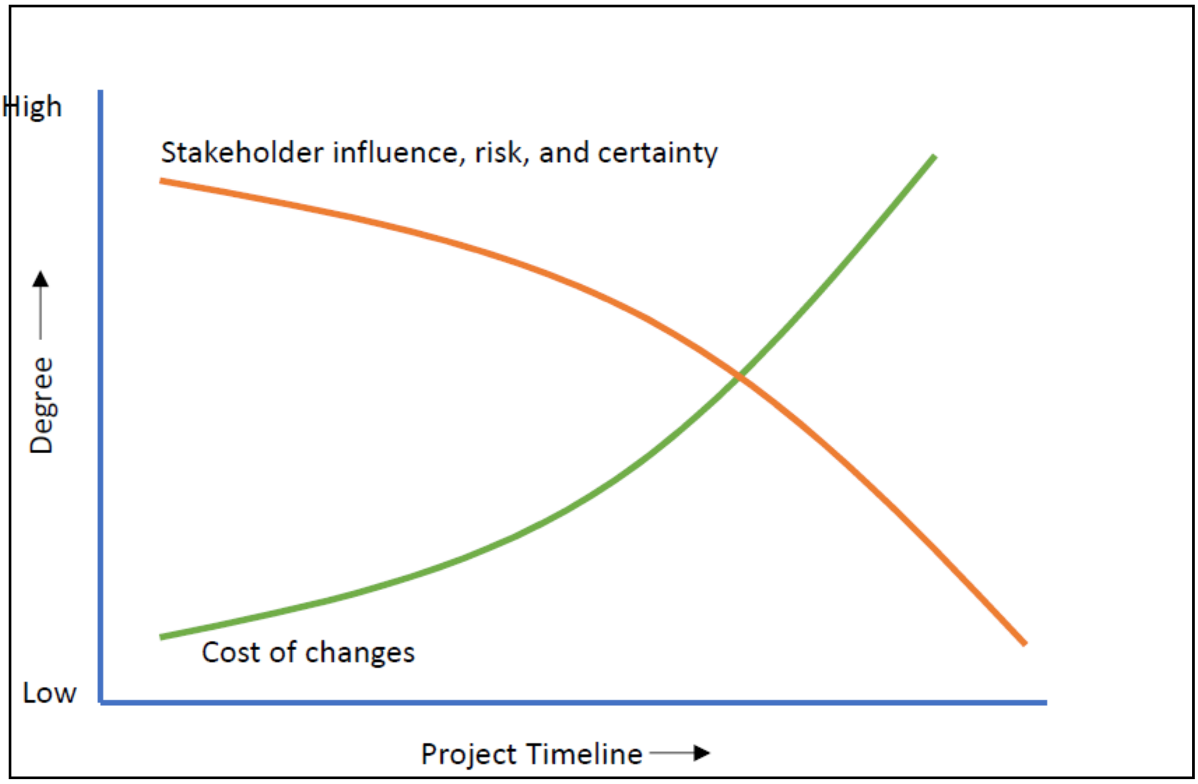
The purpose of an upfront study is to demonstrate the technical and economic viability of a project to an investor. George, Bell and Back (2008:66) note that front–end planning in construction projects is the process of developing adequate strategic information to enable owners to deal with risk. The aim is to ensure that owners can make informed decisions regarding the allocation of resources and maximise the potential for a successful outcome.

A project study is seen as a stepwise risk reduction process. As the project study progresses, more information becomes available, which reduces uncertainty, and along with It, risk. Gypton (2002:46) states that organisations cannot afford to study a project to the point of "absolute certainty", and that uncertainty and risk will always be part of project evaluations. Emblemsvåg (2017:20) states that there are three ways to deal with uncertainty and risk in projects, namely 1) forecast its impact before deciding; 2) manoeuvre or adapt to uncertainty and risk, making it irrelevant; or 3) accept it. To be able to decide on any of the three means of dealing with risk and uncertainty, it is essential to be able to identify the risk and rank it. Emblemsvåg (2017:21) holds that the planning phase of a project should be used to identify risks and decide on ways and means to navigate the risks during implementation. According to Gypton (2002: 46), the key question is; "can a project withstand the amount of risk remaining in a project after the study of the project has been conducted?"

Williams and Samset (2010:43) stress the importance of proper front–end planning in ensuring that projects are at the correct level of maturity before proceeding to implementation. Prieto (2015:2) attributes project failure to, amongst other elements, poor conceptualisation, and inherent weaknesses in the planning process. Flyvbjerg (2014: 14) holds that in most cases, those involved in the implementation of projects are not able to compensate for overlooked or underestimated problems during the study phase. Project risk planning and project risk management are thus essential parts of the project study. The risk is reduced during a project study.

Heravi, Coffey and Trigunarsyah (2015:985) state that it is easiest to influence the outcome of a project during the early stages, and that it becomes progressively more challenging to do so as projects progress. Kolltveit, Bjørn Johs, Grønhaug and Kjell (2004:547) adds that during the front–end planning stage of a project the stakeholders have the best opportunity to affect the outcome of the project positively. George et al*.* (2008:67) add that the decision made during this phase will set the direction for the rest of the project and that potential problems should be identified during this phase before they can affect the project negatively. It is also possible to identify areas of the project that require better definition before commencing with design and implementation. According to George et al. (2008:66) changes made during this phase of the project has a significantly smaller cost impact than those made later in the project life cycle. The ability of the project team to reconfigure the project also diminishes as the project proceeds. This concept is illustrated in Figure 2.1.

Steffen et al. (2008:7) state that, if the FEP phase is executed well, the project will have a comprehensive plan which accounts for risk and uncertainty through all stages of development, to maximise production and returns. The FEP process ensures that key stakeholders can participate in all stages of the project.



Source: Schoonwinkel, Fourie and Conradie (2016:22)

Figure 2.1 – Impact of variables based on project time

According to Collins, Parrish and Gibs (2015:1), the front–end planning phase of a project can have the most significant impact on minimising risk and ensuring project success. Zidane and Andersen (2018:83) state that the best way to prevent delays in projects is to identify factors which may lead to delays before the delay occurs. Zidane and Andersen (2018:89) also maintain that slow and inadequate decision–making processes lead to project delays. They advocate improved front–end planning as one way of ensuring fewer delays in projects. Efforts undertaken during this phase have significantly higher returns in ensuring project success than those during the latter stages of a project (Gibson, Kaczmarowski and Lore, 1993:2). Steffen et al. (2008:6) state that proper front–end planning contributes significantly to:

- lower overall costs;
- faster project delivery; and
- better operability of the installation.

Williams and Samset (2010:41) add that projects with adequate front–end planning, had an 80% success rate, as opposed to those with insufficient planning, which had success rates of only 20%. Williams and Samset (2010:42) also found that the quality of the study and appraisal of a project, had significantly more impact on the eventual outcome of the project, than any of the other factors considered, including the macroeconomic environment, external factors, and government considerations.

Flyvbjerg (2013:50) suggests that it is not always the best projects with the most value that get built, but instead, those who manage to design a "fantasy world" where costs are underestimated, revenues are overestimated, and environmental impacts are underestimated. Project approval often depends on these factors. Flyvbjerg (2013:51) maintains that the estimation of costs and impacts of a project should be refined to a more realistic number before a decision is made to approve a project. This can be done by conducting a more thorough study before approval of the project. Haubrich (2014) adds that projects with marginal economics are often under pressure to optimise costs and those over–optimisations often lead to cost overruns. Assumptions regarding cost savings can be too optimistic. Haubrich (2014) also maintains that the pressure to advance a project from study to implementation outweighs the pressure to ensure that cost estimates are accurate. This inevitably leads to cost overruns during implementation. Haubrich (2014) advocates for proper risk identification and risk management as a solution to this phenomenon.

Volden and Samset (2017:91–93) highlight the concept of project governance, along with the need to have a standard method to assess and approve projects for implementation. These authors maintain that many of the problems experienced later in the implementation phase of a project could have been avoided or minimised if checks, appraisals, and reviews, were addressed in the study phase, prior to final approval of the project.

Smith, Surujhlal and Manyuchi (2008:336) argue that directors, executives, and planners have a fiduciary duty to identify, evaluate and manage risk in an organisation. These risks, when applied to mining projects, are split into two categories:

- Decision–makers must navigate the risks posed by project–specific parameters, such as mineral resources (size, grade), mining method and efficiency, processing method, project ramp–up rate, capital cost, and operational cost requirements.
- They must also manage the longer–term uncertainties, which will affect the viability of a project. These uncertainties are created by the environment which the mine will operate in, several years from the time the decision is made.

It is essential to manage both the long–term risk and the project–specific risk mentioned above, to ensure that a mining project is thoroughly evaluated, at the time of project approval.

The Institute of Directors (2015:2) note that a company's Board has the responsibility to control the flow of information to it, and how information is presented to it. While it is not expected of a board member to be a subject matter expert, board members should be sufficiently informed to be able to interrogate the matter. The importance of the board's understanding of the risk, timeframe and expected costs and returns is also highlighted (The Institute of Directors, 2015:3). The board should have a mechanism to challenge any assumptions regarding best and worst–case scenarios from an operational, financial, and reputational perspective. The board must consider whether key members from outside the project team, with the required professional scepticism, have provided their inputs into the risk identification and assessment process. The Board should also adopt a process to assess the feasibility of a project and to terminate or change a project if it is found not to be aligned with the business' strategy. The importance of independent verification and assessment of capital projects is also highlighted (The Institute of Directors, 2015:5). The Institute of Directors (2015:5) highlights the following three important outcomes of an independent assurance review on projects:

- Assurance that the project management of the capital project is conforming to the company's processes and standards.
- Early detection of risks and issues which may affect the project later on.
- Recommendations on ways to remedy potential shortcomings before they become issues.

The CII, in its Pre–Project Planning Handbook (1995:11) mentions that project costs are lowered while variability on costs, schedule and operating characteristics are also positively affected if the planning phase of a project is performed successfully. The CII also recognise front–end planning as a best practice which, if executed correctly, leads to enhanced project performance. One significant sub–process of front–end planning is the creation of a projects Scope Definition package.

2.3 Project Scope Definition

Cho and Gibson (2001:115) note that the creation of a Project Scope Definition package is a significant subphase of the planning phase. They observe that the Project Scope Definition is the subphase during which projects are defined and prepared for implementation. During this phase, risks relating to the project are analysed, and the project implementation approach is defined. Dumont, Gibson and Fish (1997:55) note that a Scope Definition package is a "detailed formulation of a continuous and systematic strategy to be used during the implementation phase of a project to accomplish the project objectives and fulfil the driving business need." They observe that this package should contain adequate information to enable detailed engineering. It is also remarked by Dumont et al. (1997:58) that poor Project Scope Definition can result in overruns in costs as well as in disputes. Poor Scope Definition is also mentioned as a potential cause of project delays, rework and lower productivity and morale.

Torp, Belay, Thodeson and Klakegg (2016:1182) found that scope and design changes were the single most significant factor contributing to cost overrun during construction projects. Prieto (2015:49) suggests that scope should not only consider the technical requirements but also include the strategic outcomes which the owner wants to achieve and the requirements from external stakeholders. Muldowney (2015:1) notes that project scope changes can create chaos in a project over time. While it may be possible to recover from excessive scope changes on a small project (if project personnel are willing to work excessive hours), this is most often not the case with megaprojects. Even if people are dismissed and replaced, Muldowney (2015:1) believes that a project cannot be brought back under control once too many scope changes have occurred.

Hamilton and Gibson (1996:26) concluded that due to the savings in cost and schedule which come with improved project predictability, a project benefits from complete Project Scope Definition.

2.4 Determining the status of a project

Before proceeding to the next phase of a project, it is important for a company to determine if the project complies with the requirements for it to do so (De Wet, 2007:13). This could be done via an audit, a health check, or a review session. The goal with these sessions is to determine if the project is indeed ready to proceed to the next phase and if the necessary work has been done in the current phase.

A project review is a governance tool which 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, 2006:37).

The four main objectives of a project review, as mentioned by Englund and Bucero (2006:38), are:

- Establishing if a project can proceed to the next phase (go / no–go decision – often associated with a stage–gate process).
- 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 organisation (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 include (Duffy and Thomas, 1989:102):

- Being proactive instead of reactive with regards 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 include (Conroy and Soltan, 1998:188):

- 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 seen as challenges rather than an aid.
- The lack of availability of competent reviewers could hamper proper auditing.

Conducting project reviews at the end of each stage of a project's lifecycle can add value, as it helps decision–makers to make informed decisions. It can also assist the project team in identifying 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. Additionally, for project reviews to be effective, some form of review or assessment criteria are required to ensure a structured process. An agreed–upon assessment tool should also assist in removing bias.

2.5 Important considerations in project assessments

A number of defining elements need to be considered before examining the existing project Readiness Assessment tools.

Van Wyngaardt, Pretorius, and Pretorius (2012:1992) mention the Theory of Triple Constraints in project management, which holds that cost, schedule and scope form the three sides of the project management triangle. Quality influences all three sides. Van Wyngaardt et al. (2012:2993) says these three elements of project management compete, and one of the constraints will typically dominate. Time–constrained projects will be bound by the end date or delivery of specific milestones, while cost–constrained projects are bound by the overall cost and timing of cost flow during the project. Scope–constrained projects must ensure that deliverables perform according to expectation. The Triple Constrained Theory holds that for any project which is constrained by one of the variables, that variable can be delivered at the expense of one or both remaining variables. This, in turn, affects the quality of the deliverables. Understanding the relative importance of the three constraints on any project is important.

Martens and Carvalho (2017:1095) argue that sustainability is an important factor to consider in any project. The triple bottom line approach of considering the environment, economy and impact of the social aspects of a project, will assist in ensuring integration of a project.

Prieto (2015:53) stresses the importance of knowledge management in projects and advocates for the free flow and availability of knowledge and information to all members of a project team. He also suggests that the project team should be continuously educated during implementation Knowledge sharing must form part of the implementation plan.

Slaviero and Mercier (2011:8) note that it is important to not only focus on a specific project but to take a longer–term view regarding developing a sustainable project organisation. On the job training, internal mentoring, external coaching, and formal academic training (internal and external) should be part of the project plan, to ensure that the project team is developed for current and future roles within the organisation. Steffen et al. (2008:9) add that capturing lessons learned during a project and considering them in future projects enhance the capabilities of the project organisation.

Flyvbjerg, Stewart and Budzier (2016:5) highlight the importance of accurate cost estimates, along with the difficulties experienced in determining the correct cost estimate of complex projects. They advocate for the use of “reference class forecasting”, along with the standard bottom–up approach to calculating project cost estimates. Reference class forecasting refers to using similar completed projects to aid in estimating the cost of proposed projects. Doing so helps account for bias when establishing the cost estimate for a proposed project.

Williams and Samset (2010:45) note that the strategy of an organisation is an important consideration in projects. All projects should be aligned with the company strategy.

2.5 Available Readiness Assessment tools

In the previous sections, some of the critical considerations on projects as it relates to project success and front–end phases were explored. The need to thoroughly study a project prior to implementation was shown, along with the pitfalls when this is not done.

Various industries and companies have adopted different tools for evaluating projects before approval to proceed into detail design and implementation. Some of these tools are aimed at determining which projects should proceed, given a capital–constrained environment, in which projects must compete for a limited pool of capital (Berechman and Paaswell, 2005:224). These tools typically focus on attempting to decide which projects will deliver the best value for money, given the limited availability of capital. As such, the focus is sometimes more on portfolio management than on trying to evaluate a specific project to determine its state of readiness to proceed into 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, 1995:69).

Tools, such as the Fischer exact test, attempt to identify the characteristics of specific types of projects (for example power plants) which correlate with schedule and Cost Performance (Brookes and Locatelli, 2015:59). By using this type of analysis, it is possible to identify the various factors which contribute to the failure or success of projects in a specific industry. The 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 Advanced Planning Risk Analysis (APRA) tool developed by the Texas Department of Transport is a risk management tool which focuses on improving a project's scope clarity and comprehensiveness (Bingham, 2010:35). It was developed specifically to be easy to use, and to measure the degree of scope development early in a project. It also helps 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, 1996:15). It attempted to quantify the degree of Scope Definition in industrial projects at a given stage. In 1990 a revised Definition Rating Checklist was published by Hackney to account for changes in political, economic, and engineering conditions (Gibson and Dumont, 1996:16).

Some of the project status evaluation models which are available for end–users to embed in organisations, may not be specific enough for mining projects. One such tool is the Project Health Check Model (Buttrick, 2000:15). This tool focusses on assessing the overall risk associated with a project. It does so by focusing on seven critical project success factors, namely:

- Project plan – The availability of a detailed project plan which includes costs, accountabilities, and contingency plans
- Resources – Are adequate human resources assigned and are they aware of their responsibilities?
- Ownership – Do stakeholders understand the limitations of the project and which of their expectations have been included in the project?
- Justifiable case – Is the business case of the project sound and have all the factors which influence the project been considered?
- Expertise – Is the project team competent and has training been included as part of the project plan?
- Specifications – The objectives and requirements are clear to all stakeholders and has been documented.
- Support – Is the sponsor committed and does top management understand their roles?

The Project Implementation Profile model closely emulates that of Buttrick (Pinto, 1990:178). Pinto's model focusses on the following factors in evaluating a project:

- Project mission – Clarity of goals and direction
- Top management support
- Project schedules/plans
- Client consultation
- Personnel

- Technical tasks – Availability of technology and expertise
- Client acceptance
- Monitoring and feedback – Are project controls in place?
- Communication – Does the correct information reach the intended recipients?
- Troubleshooting – How are unexpected deviations handled?

Like Buttrick, Pinto's (1970) model concentrates on the general Project Management requirements, such as the right personnel, top management support and project controls. While these are common to most projects, it does not address the unique challenges which projects in different industries face. Pinto and Buttrick's models do not directly address any of the unique characteristics of mining projects.

Other tools which have been put forward include those of Englund and Bucero (2006:231), which focusses on nine evaluation criteria during review sessions. These are scope management, time management, cost management, quality management, human resource management, communication management, risk management, procurement, and customer satisfaction. Bolles (2002:17) focuses on 12 project success factors during evaluations, namely project status update cycle, change control process, issue resolution process, steering team established, baseline plan, project budget, scope statement, the Role / Responsibility / Accountability / Authority matrix, communication plan, risk assessment, metrics plan and management plan.

Duffy and Thomas (1989:102) mention the WS Atkins Performance Auditing Methodology which is based on nine project success factors, namely organisation and management, project definition, time, money, procurement strategy, communication, site, restraints and commissioning and operations. The Stage–Gate process described by Cooper, Scott, and Kleinschmidt (2002:46) can typically be used to assess projects. It results in a decision to either proceed into the next stage or "kill" the project. A balanced scorecard methodology is proposed as a manner of evaluating a project at each phase of a project (Germain, 2000:46). The four criteria which are evaluated in this manner are financials, internal processes, end–user orientation, and learning and growth. The tools mentioned above are all generic, and concentrate on the basic requirements of project management, including time and cost, without addressing the unique challenges in a specific industry.

Gateway reviews are another type of independent peer review which could potentially be used to evaluate a project. (Kells, 2011:63). Typically, these reviews are conducted at specific "gates" or stages of a project. A checklist is used to determine if a pre–determined set of criteria has been achieved. These are based on best practice, such as the internationally accepted Project Management Body of Knowledge (PMBOK) (Kells, 2011:64). 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. The evaluation relies on the view of the independent auditor.

Kells (2011:65) puts forward t wo other forms of project audits, namely performance audits and probity audits. However, these are noted as being retrospective, and thus will not assist in enabling decision–makers to decide on the approval of projects for detail design and implementation. Kells specifically notes that none of these evaluation mechanisms have been consistently successful in overcoming problems which typically lead to project failure.

There have been attempts to automate the project evaluation procedure. Current systems, such as the concurrent simultaneous engineering resource view (ConSERV) system (Conroy and Soltan, 1998:186) evaluate project risks on a continuous basis during the project lifecycle. The system places a significant demand on the time of project members and results in the risk of project members becoming too reliant on the system.

According to Messner and Sanvido (2001:397), organisational based information architecture (OBIA) offers a system which can be used to evaluate projects. Areas which require more work can be identified by entering the relevant information regarding a project into the system. The major shortcoming of this system is that it does not provide a rating score which would enable decision–makers to compare various projects with each other.

A Single–Period Project Selection (SPPS) system is a single parametric weighing system which could be used to evaluate a project based on a single determinant of potential success (Eben–Chaime, 2000:56). The fuzzy stochastic dominance model is proposed as a tool to enable multiple attribute decision making (Wong, Norman, and Flanagan, 1999:409). Although this method could be used to provide valuable information regarding project status, the resulting rating needs to be compared to that of previous successful projects in the organisation and interpreted by experts. The result is not easily interpreted by non–technical personnel.

Most of the available tools focus more on the organisational and management issues and tend to focus less on the technical issues for project evaluation (De Wet, 2007:23). Mining projects by nature depend in no small degree on the accuracy of geological and other technical information developed during the study phase. Any tool which attempts to appraise potential mining projects will require a thorough evaluation of the applicable technical as well as non–technical parameters.

Some tools attempt to assist project teams in determining the level of readiness of a project to proceed into implementation. The tools are, however, either not explicitly tailored for mining projects with all of its unique characteristics, or they are not freely available to project teams to use as a self–assessment tool during the FEL stages. The tools which are available can be classified into the following types:

- Generic tools which can be used to assess project readiness but are not specific to the mining Industry.
- Tools used in other industries that are industry–specific, but not to the mining industry.
- External proprietary tools are developed by consultants and are not freely available to mining project members unless the consulting firm is hired to carry out the assessment.

According to Bastianelli and Yeager (2012:2), 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 into detail design and implementation. Berkley Research Group (Bastianelli and Yeager, 2012:5) mentions many advantages of using external facilitators during project development and evaluation. These include that consultants be familiar with industry best practice and that they must have project experience. Consultants must also be unbiased as regards internal politics and be available for periodic follow–up assessments via audits and checks. The use of external consultants is especially advised when owner organisations do not have adequate internal resources.

The firms that offer external project evaluation and assurance services use various method to collect data and interpret and evaluate the state of a project at a given time. The methodology and tools used during the assessment are, however, not freely shared freely with the client, as this would impact on the consulting firms' ability to sell its services in future. One such service provider is Independent Project Analysis (IPA) who owns a library of project data from which project Readiness Assessments are calculated and derived (Motta, et al., 2014:407). While the use of consultants may assist in ensuring that industry best practices are utilised and that findings are not influenced by the biases of internal resources, the knowledge is not embedded within the project organisation. Knowledge regarding the tools and techniques utilised is not transferred to the end–user.

One of the ways in which companies are trying to be more competitive involves embedding project management as a key competency in the organisation (De Wet, 2007:11). The project evaluation process is an important input into continuous development and should be carried out by a team over several projects to achieve maximum learning (APM, 2006:34; Brown and Remenyi, 2002:8; Banwell and Proud, 2003:81; Frechtling, 2002:45). Evaluation of projects is knowledge–creating and assists in capacity building (Vakola, 2000:813; Segone, 1998:19; Farbey, Land and Targett, 1992:111). The issue of subjectivity, however, needs to be addressed when evaluations are handled in–house. One way of dealing with this would be to have members of different teams evaluate each other or to have a dedicated assessment team, which operates independently from the project teams. It is important to embed a model of project evaluation which allows for self–evaluation by project teams. Such self–evaluation becomes more difficult when external consultants manage the process (Oral, Kettani and Lang, 1991:873).

Project evaluations should be cost–effective and produce the desired results with minimum undesirable side–effects (Grabe, 1983:18). The appointment of external consultants who do not transfer knowledge to the end–user may not serve the end goal of upskilling the project community within a company. It is more difficult to embed a model of project evaluation which allows for self–evaluation by project teams when external consultants manage the process (Oral, et al., 1991:875).

The tools which consultants use are not tailored to each specific end–user but based on a generic approach, which may not take the unique requirements of individual organisations into account. Multiple scrutinising bodies (such as when a project is evaluated by in–house assurance as well as external consultants) can lead to wasteful duplication of effort, contradictory conclusions and thus higher participation costs and less effective results. (Kells, 2011:65). Kells also note that project teams may not be willing to make candid disclosures to "friendly" reviewers. The culture of the organisation influences this. A summary of the assessment tools discussed is provided in Table 2.2.

Table 2.2 – Various tools currently used to assess project readiness

Tools used in other industries		
Name	**Reference**	**Shortcomings**
Construction Industry Institute (CII) PDRI tools	Gibson and Dumont, 1996: 17	Does not address all mining elements
Fischer exact test	Brookes and Locatelli, 2015: 58	Does not assess Scope Definition at a specific point in time
3rd party proprietary tools		
Independent Project Analysis (IPA)	Gibson and Dumont, 1996: 17	Not freely available
KPMG consultants	Motta et al., 2014	Not freely available
BDR consultants	Motta et al., 2014	Not freely available
PWC (Price Waterhouse Cooper)	Motta et al., 2014	Not freely available

Generic tools		
Advanced Planning Risk Analysis (APRA)	Bingham, 2010: 47	Focuses on transport projects
Definition Rating Checklist	Gibson and Dumont, 1996: 29	Caters for industrial projects only
Revised Definition Rating Checklist	Gibson and Dumont, 1996: 29	Caters for industrial projects only
Project Health Check Model	Buttrick, 2000: 87	Focusses on high–level issues, not detailed enough for mining projects
Project Implementation Profile	Pinto, 1990: 175	Focusses on high–level issues, not detailed enough for mining projects
Englund & Bucero model	Englund & Bucero, 2006: 148	Focusses on high–level issues, not detailed enough for mining projects
Generic tools		
Bolles model	Bolles, 2002: 5	Focusses on high–level issues, not detailed enough for mining projects
WS Atkins Performance Auditing Methodology	Duffy and Thomas, 1989: 103	Focusses on high–level issues, not detailed enough for mining projects
Stage–gate process	Cooper et al.,2002: 44	Focusses on high–level issues, not detailed enough for mining projects
balanced scorecard methodology	Germain, 2000: 46	Focusses on high–level issues, not detailed enough for mining projects
Gateway reviews	Kells, 2011: 62	Focusses on high–level issues, not detailed enough for mining projects

(ConSERV)	Conroy & Soltan, 1998: 187	Time–consuming and mostly focussed on risks
Organisational based information architecture (OBIA)	Messner & Sanvido,2001: 395	Does not provide a rating score to compare projects easily
Single Period Project Selection (SPPS)	Eben–Chaime, 2000: 56	Needs expert inputs in order to interpret results
Fuzzy stochastic dominance model (SFD)	Wong et al., 1999: 409	Needs expert inputs in order to interpret results

Given the proprietary, generic or industry related nature of available Readiness Assessment Tools, an accurate, generally available assessment tool for mining projects remains elusive. However, given the scientific structure and empirically developed nature of the available PDRI tools, this study based the development of a mining project RAT on the PDRI process and format.

The following paragraphs provide information on the origin of PDRI tools, its development through many years, and the different types of PDRIs available. This will be followed with information on the specific nature and variables of mining projects as well as the proposed approach towards the development of concept models for further research.

2.6 Project Definition Rating Index (PDRI)

The Construction Industry Institute (CII) is a research consortium based at the University of Texas. The member organisations include owners, engineering contractors and suppliers from the public as well as the private sector. The institute is based at the University of Texas at Austin in the United States of America. The mission of the CII is to inspire all role–players in the construction industry, including academia, to work together on research that will result in best practices. It also aims to create solutions which will improve safety and capital efficiency. (CII Annual Report, 2014:5). The CII has four knowledge processes, namely knowledge creation, knowledge dissemination, knowledge assessment and knowledge management. In the knowledge creation process, the CII research teams generate best practices for the construction industry. The research teams are typically groups that include academic researchers and employees representing owners and contracting firms. One of the focus areas of CII research is front–end planning in projects.

The CII has been involved in research focused on the front–end planning phases of projects since the mid–1980s. This focus included the study of Project Scope Definition before the implementation phase of a project. It also focusses on the role Scope Definition plays in ensuring project success, as well as the impact on project risks. This led to the CII developing several Project Definition Rating Index (PDRI) tools.

A PDRI is a tool which evaluates the level of definition of several elements which should be addressed during a study of a project. Each element is assigned a weight, based on its relative importance and potential influence on project success. When the level of maturity is assigned to the weighted elements, a PDRI score can be calculated for a project study. This score gives an indication of the level of readiness of the study project to proceed into implementation. The use of PDRI also allows for the identification of specific elements that do not have sufficient maturity, and require additional work.

Before 2016, four such sets of tools were developed, namely the PDRI for Industrial Projects (1997), the PDRI for Building Projects (2001), the PDRI for Infrastructure project (2010) and the PDRI for Small Industrial Projects (2015).

The PDRI for Small Industrial Projects (Construction Industry Institute, 2015:1) was developed by research team 314 in 2015 to cover small industrial projects (valued at less than $10 million and with durations between three and six months). It consists of 41 elements across eight categories and three sections. As part of the PDRI for Small Industrial Projects, a table is provided to guide the user in deciding which PDRI to use for various applications (Construction Industry Institute, 2015:2). See Table 2.3. Although the PDRI for Industrial Projects is indicated as the applicable PDRI for oil/gas production facilities, none of the PDRIs is indicated as the applicable PDRI for mining projects. Instead, several elements from each of the PDRIs addresses some of the elements of a mining project. The PDRI for Industrial Projects is shown as applying to Refineries and Water/Wastewater treatment plants, which could form part of a mining project.

Table 2.3 – Applicable project type for each PDRI

Industrial Projects (IR 113–2, IR 314–2)		
Oil/gas production facilities Textile mills Chemical plants Pharmaceutical plants Paper mills	Steel/aluminium mills Power plants Steam heat/chilled water plants Manufacturing facilities	Food Processing plants Refineries Water/wastewater treatment Plant upgrade/retrofit
Infrastructure Projects (IR 268–2)		
Pipelines Aqueducts umping and compressor stations Locks, weirs Reservoirs Meters and regulator stations Pig launchers and receivers	Water control structures Levees Highways Railroads Access ramps Airport runways Canals	Electricity transmission / distribution Fibre optic networks Wide area networks Electrical substations / switchgear Towers Security fencing
Building Projects (IR 155–2)		
Offices Schools (classrooms) Banks Research and laboratory facilities Medical facilities Nursing homes Institutional buildings	Dormitories Apartments Hotels and motels Parking structures Toll booths Warehouses Light assembly and manufacturing	Recreational and athletic facilities Public assembly and performance halls Industrial control buildings Government facilities Churches Airport terminals Stores and shopping centres

Source: Construction Industry Institute (2015:2).

The PDRI for Infrastructure Projects applies to pipelines, pumping and compressor stations, reservoirs, railroads, access ramps, tunnels, security fencing, electricity transmission/distribution, fibre optic networks, electrical substations/switchgear and towers, that may be encountered as part of a mining project. The PDRI for Building

Projects applies to offices, laboratory facilities, warehouses, and industrial control buildings, which could be encountered on a mining project. It is clear from Table 2.3 that mining projects have some commonalities with the existing PDRIs, but that none of the existing PDRIs covers all the unique elements which need to be addressed during a mining project study.

The PDRI for Small Industrial Projects provides a summary of the main characteristics of infrastructure, building and industrial projects (Construction Industry Institute, 2015:3). This summary is meant to guide the selection of the appropriate PDRI. The characteristics of a mining project have been added in Table 2.4. These characteristics are based on the researchers experience in mining projects, which covers 25 years. This serves to indicate the unique characteristics of mining projects. From Table 2.4 it is evident that although there are several elements from the various PDRIs which apply to mine projects, a mining project does not fit into any single existing PDRI.

Several of the elements which are applicable to mining projects, and which should be considered during the study of the projects, are not addressed by any of the existing PDRIs.

Although the existing PDRIs all address the Basis of Project Decision as the first section, the categories in this section do not cater for elements that are important in mining projects. These categories include the evaluation of the jurisdiction where the project will be executed; the calculation and accuracy of the ore reserve, the in–depth production methods and capacity analysis (including life of mine planning, levels of mechanization and waste plans), revenue generation assumptions regarding royalties, government charges, hedging, and import/export law.

Table 2.4 – Project Sector Characteristics

PDRI selection matrix				
Characteristics	**Infrastructure**	**Building**	**Industrial**	**Mining**
Primary designer	Civil Engineer	Architect	Chemical, mechanical, industrial	Mining, geotechnical, civil, mechanical, electrical, process, industrial
System	vector	node	node	Vector
Utilization	conveyance	functional use	transformation	conveyance, transformation, functional use
Interface with public	extensive	moderate	minimal	Extensive
Environmental impact	extensive	moderate	extensive	Extensive
Primary cost	earthwork, materials, associated structures	buildings, building systems	piping, mechanical equipment	geological investigation, earthworks, mechanical equipment, associated structures
Installed equipment cost	minimal	moderate	extensive	Extensive
Land cost	moderate to high	low to high	low to moderate	High
Jurisdiction interface	extensive	moderate	moderate	Extensive

Source: Construction Industry Institute (2015:3).

Another area that is important to a mining project, and which are not adequately addressed by the existing PDRIs, include the social and environmental requirements of mining projects. These include unique mine closure plans, planning for land use post operations, relocation action planning, community risks, sustainability planning, social investment, and economic diversification planning. Value Improving Practices (VIPs) such as design to capacity, 3D/4D design, classes of facility quality, energy efficiency, and waste minimisation are other examples of elements which are not addressed in the existing PDRIs, but are essential in a mining project study.

The operational readiness and handover requirements between the project implementation team and operation is another area that is not adequately addressed in the previous PDRIs. Resourcing of operational staff, along with training requirements, maintenance schedules, critical spares and Start–up consumables are not addressed individually in the existing PDRIs but are very important in commissioning and handing over a mining project. Ensuring that supply contracts and environmental management plans for operations are in place is another key area.

Although the previous PDRIs have certain elements which apply to mine projects, no single current PDRI caters for all the unique elements of a mining project. Even if the elements of the previous PDRIs are combined, there are elements which are not adequately addressed.

The CII, in its Publication 113–1 (Dumont, Gibson and Fish, 1997:55), created a manual that provides a tool for measuring the level of front–end planning. This can be used to identify areas where more work should be done before proceeding to the detail design and implementation phases of a project. Cho and Gibson (2001:115) observe that a PDRI is a project management tool which assists both project team members and assurance reviewers. It does this by calculating a mark which represents the level of the project definition. The tool provides project team members with a structured means for developing a well–defined scope of work.

According to Cho and Gibson (2001:121), the PDRI can improve all five significant sub–processes of pre–project scope planning. These are initiation, scope planning, scope definition, scope verification and scope change control. This can assist the project team in understanding the Project Scope Definition requirements and objectives. The PDRI can also assist the team in determining the critical elements in the scope package, which will assist in compiling a work break down structure (WBS) and developing proper milestones. The PDRI also provides a structured method to define the scope of a project. By assigning a score to the various elements, the future effort can be channelled to those elements which are shown to require the most attention. By identifying the areas of weakness or shortcomings, a PDRI can assist with risk management and project evaluation. The PDRI can be used as a tool to focus the project team's effort during the design and implementation phase The tool concentrates on those elements that did not achieve satisfactory marks before implementation and helps improve the definition.

The PDRI set of tools has an excellent track record. The CII has benchmarked over $96 billion in capital projects and found that the use of a PDRI can lead to:

- up to 25 % cost savings
- up to 17% schedule reduction

It was also found that projects which have ensured the adequacy of Scope Definition using a tool such as a PDRI have fewer scope changes and associated costs later in the project (Gibson and Dumont, 1996:75).

Before the creation of the RAT for Mining Projects, four PDRIs were developed by the CII. These are PDRI for Industrial Projects, PDRI for building projects, PDRI for Infrastructure Projects and PDRI for Small Industrial projects. The PDRI for Industrial Projects was released in 1997 by the CII. It consists of 70 Scope Definition elements in a weighted checklist format. It is divided into three main sections and 15 categories (Gibson and Dumont, 1996:29). Due to the success of the PDRI for Industrial Projects, a PDRI for Building Projects was created in 2001. This PDRI consists of 64 Scope Definition elements, three sections and 11 categories (Cho and Gibson, 2001:116). The PDRI for Infrastructure Projects was brought about through the establishment of research team 268 in 2008. According to Bingham (2010:25), this team divided infrastructure into three main categories, namely transportation of people and freight, energy, and fluids. The PDRI for Infrastructure Projects consisted of 68 elements which were divided into three sections and 13 categories. The PDRI for small industrial projects (Construction Industry Institute, 2015:1) was developed by research team 314 in 2015 to cover small industrial projects (valued at less than $10 million and with durations between three and six months). It consists of 41 elements across eight categories and three sections.

The success achieved by the CII in its suite of PDRI tools has led other industries and companies to develop similar tools based on the PDRI. These include the US Department of Energy, NASA, and ESKOM (Lotz, 2015:26). The four PDRIs which was created prior to 2017, will be discussed in the next four sub–sections.

2.6.1 PDRI for Industrial projects

The CII released the PDRI for Industrial Projects in 1997. It consists of 70 Scope Definition elements in a weighted checklist format. It is divided into three main sections and 15 categories, according to Gibson and Dumont (1996:13). A mark is given for each of the elements based on the level of maturity of the element, and a combined score is calculated. A lower mark indicates a better–defined project, and the goal is to get as low a score as possible, as this would point to a sounder Scope Definition. A score below 200 has been shown to significantly increase the predictability of a project's outcome. Gibson and Dumont (1996) found that cost saving of 19%, schedule reduction of 13%, fewer project changes, and increases in the operational predictability were a direct result of achieving a score below 200 using the PDRI for Industrial Projects.

2.6.2 PDRI for Building Projects

The success of the PDRI for Industrial Projects, led to a PDRI for Building Projects having been created in 2001. This PDRI consists of 64 Scope Definition elements, with three sections and 11 categories. (Cho and Gibson, 2001:116). A 12–member research team participated in the creation of the PDRI for Building Projects.

Seven weighting workshops were conducted, each lasting approximately four hours. A total of 69 experienced project managers, architects and engineers were involved in the workshops. The workshop participants represented owners and contractors. The PDRI was then validated using surveys which were sent to a non–random sample of participants in 33 completed projects. The participants were asked to rate the completeness of their project for each of the 64 elements at the end of the planning phase.

The eventual PDRI for Building Projects score sheet allows for a score of between 70 and 1000, with a lower mark indicating a better Scope Definition. A mark of 200 was found to be statistically significant. Projects with scores below 200 had significantly less change orders, were more successful regarding cost and time, and were generally rated as more successful than projects with scores above 200.

By testing the PDRI for Building Projects on ongoing projects also, the research team found that the PDRI is a useful tool for identifying specific problems during the planning phase and aligning project team members (Cho and Gibson, 2001:118).

2.6.3 PDRI for Infrastructure Projects

The PDRI for Infrastructure Projects was brought about through the establishment of research team 268 in 2008. According to Bingham (2010:25), this team divided infrastructure into three main categories, namely transportation of people and freight, energy, and fluids. The PDRI for Infrastructure Projects consisted of 68 elements which were divided into three sections and 13 categories. The three main areas of focus in infrastructure projects are covered in the three sections. These are the basis of project decision, the basis of design, and implementation approach. A total of six workshops were conducted to weight the elements, involving 64 participants from 28 organisations representing owners and contractors.

The PDRI was tested against completed projects, that were considered “successful” or “unsuccessful”. A questionnaire consisting of an unweighted PDRI score sheet and questions regarding the level of success of the project was sent to participants. The participants consisted of construction managers and owners. All representatives were familiar with the project’s cost, schedule, change orders and other information. In the survey, 22 projects were represented, covering 14 organisations, 19 of the projects were new construction projects, while three were renovations. Based on a

PDRI scoring of Scope Definition at the end of the planning phase, a score of 200 was again found to be significant in estimating the likelihood of success.

2.6.4 PDRI for Small Industrial Projects

The PDRI for small industrial projects was completed in 2015 by research team 314 of the CII. Small projects were defined as those with a value of less than US $10 million, and a duration of between three and six months. Small projects were also defined as being less complex than large projects. These are typically more routine projects, that are allocated to less experienced project personnel. The front end loading often falls short of the desired levels.

Since around 70 per cent of all industrial projects fall into the classification of “small”, the CII deemed it necessary to develop a separate PDRI for Small Industrial Projects. 65 industry experts with an average of 20 years’ experience participated in the study. The PDRI for Small Industrial Projects consists of 41 elements, across eight categories and three sections. As stated previously, none of the existing PDRIs caters to the unique nature of mining projects.

In the next section, the characteristics which differentiate a mining project from those in other sectors will be further explored, to determine some of the elements which must be addressed in a mine–specific RAT, and further highlight the need for a RAT for mining projects.

2.7 Mining projects

Projects in each industry are distinctive due to individual characteristics and constraints which are unique to a specific industry. Projects in the mining industry differ from those in other industries in several ways. One the of most important factors to consider in the mining industry is that the location of the project is determined by the location of a mineral deposit, as opposed to the area with the lowest production cost (Iloiu et al., 2016:7). Kuhn and Visser (2014:106) mention elements of mining projects that differ from those of other projects. These include that there is more uncertainty than most other projects. Long study and implementation phases, unpredictable and rapidly changing commodity prices, and difficult to predict escalation formulas, all contribute to the high levels of uncertainty in mining projects (Kuhn and Visser, 2014:106).

Rudenno (2012:2) notes that the mining industry is very capital hungry due to the high development costs and a high degree of mechanisation required to deliver competitive products through economies of scale. Some of the unique characteristics of the mining industry include:

- 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 subject to the forces of supply and demand, the prices of commodities are beyond the control of mining companies;
- Environment – Due to the need to minimise environmental impact and strict legislation, mining projects incur additional costs, while operating costs are also impacted in the long run;
- Land rights – The demands 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;
- Capital intensity – There are several factors which result in the mining industry being highly capital intensive, namely
  - Exploration costs – as mentioned above;
  - Economies of scale – due to relatively low prices of products, the mines need to deliver large amounts of product to make sufficient revenues; and
  - Isolation – mining projects are often constructed in remote areas, which means that infrastructure such as roads, railways and ports, runways, water and electricity, housing and other infrastructure need to be developed as part of the project.

Dehghani and Ataee–pour (2014:125) categorise the three primary sources of uncertainty at the beginning of a mining project as follows:

- *Exploration uncertainties* occur during the resource evaluation stage and include risks relating to geology, data collection, interpretation, modelling, deposit classification and reporting;
- *Engineering uncertainties* include bench heights determination, planed grade control, minimum stoping widths, choice of stoping method, dilution factors, geotechnical and hydrological parameters, mining recovery factors and metallurgical recovery; and
- *Economic uncertainties* are another activity which can affect the project evaluation. Future metal prices and operating costs are noted as the most important factors relating to this uncertainty.

Botin (2009:210) adds safety and security concerns as well as social concerns to the list of issues which mining projects must deal with to be successful. Project teams must demonstrate to local communities that the project will bring about sustainable long–term benefits to the community while protecting it from adverse impacts. Some of the social risks mentioned by Botin (2009:224) include health and safety risks such as dust and noise, impacts on water and ground resources, immigration due to the project and operations, resettlement of communities, and risks to artisanal miners in the local population.

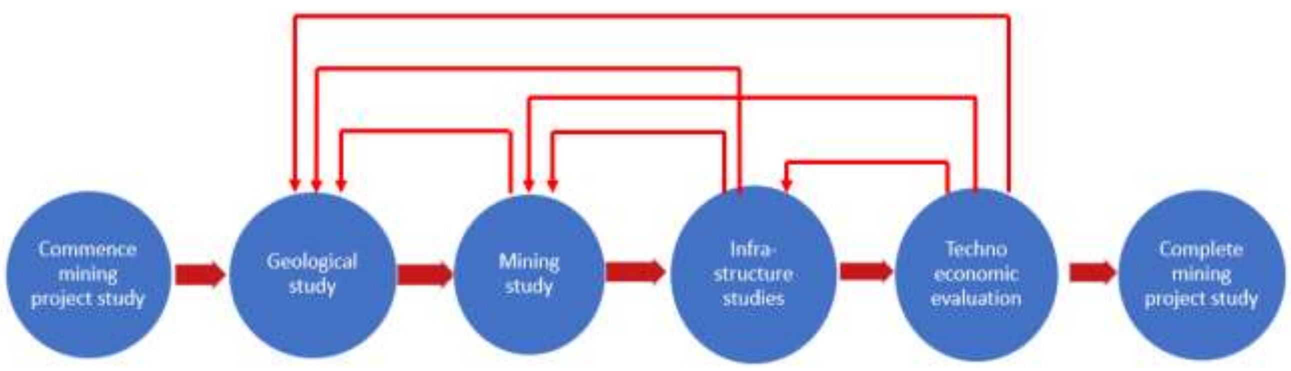
Botin (2009) also adds “country risk” to the list of issues. This risk refers to the geopolitical and other risks associated with doing business in a specific country.

Runge (1998:163) comments that royalties and government charges are also factors that are unique to mining projects. Kennedy (1990:396) adds that the front–end loading of a mining project must consider not only the mining of the reserve, but also all activities required to beneficiate and process the ore, and all the associated infrastructure. The objective of the project is also noted by Kennedy (1990:396) as being important. Considerations such as local unemployment or government policy are important drivers which may direct a project in a particular direction.

Kuhn and Visser (2014:106) list some of the many disciplines involved in most mining projects. These include:

- Geology – mineralogy and structural geology;
- Mining – logistical, ventilation, and rock engineering;
- Infrastructure – civil, mechanical, and electrical engineering;
- Techno–economic valuation – valuation and financial appraisals; and
- Value chain – metallurgy and optimisation

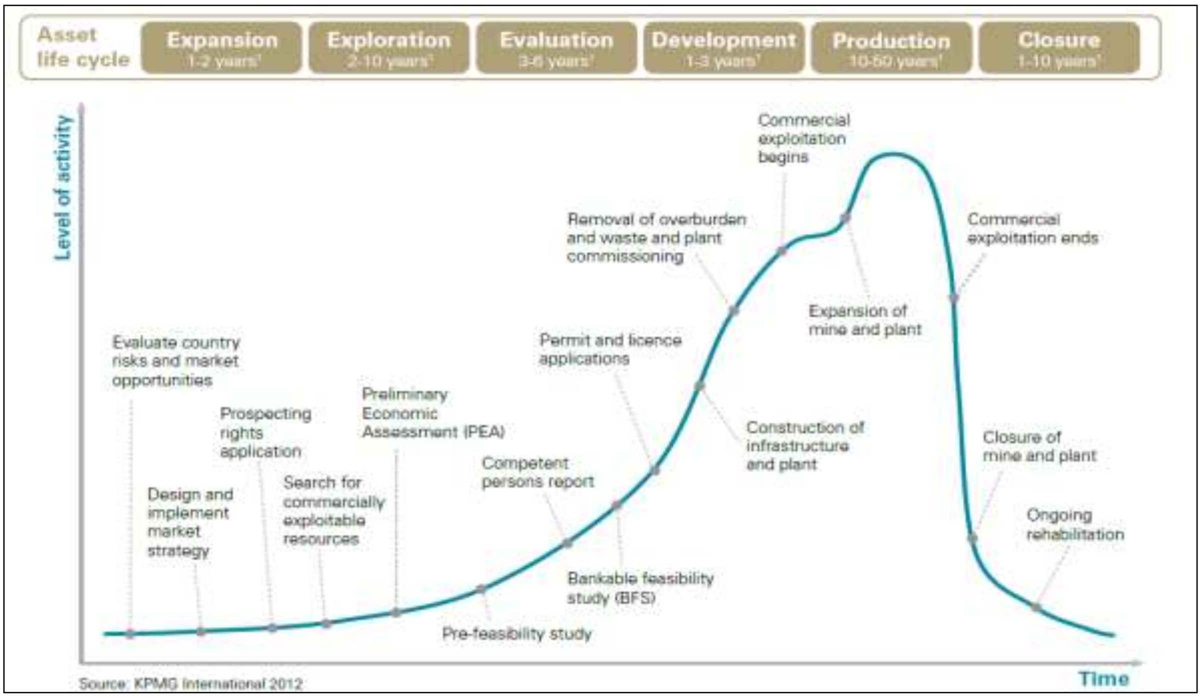
To ensure a successful project, these disciplines need to be integrated during the lifespan of the project study. A typical study is depicted in Figure 2.2.



Source: Kuhn and Visser (2014:106)

Figure 2.2 – Typical mining project study lifecycle

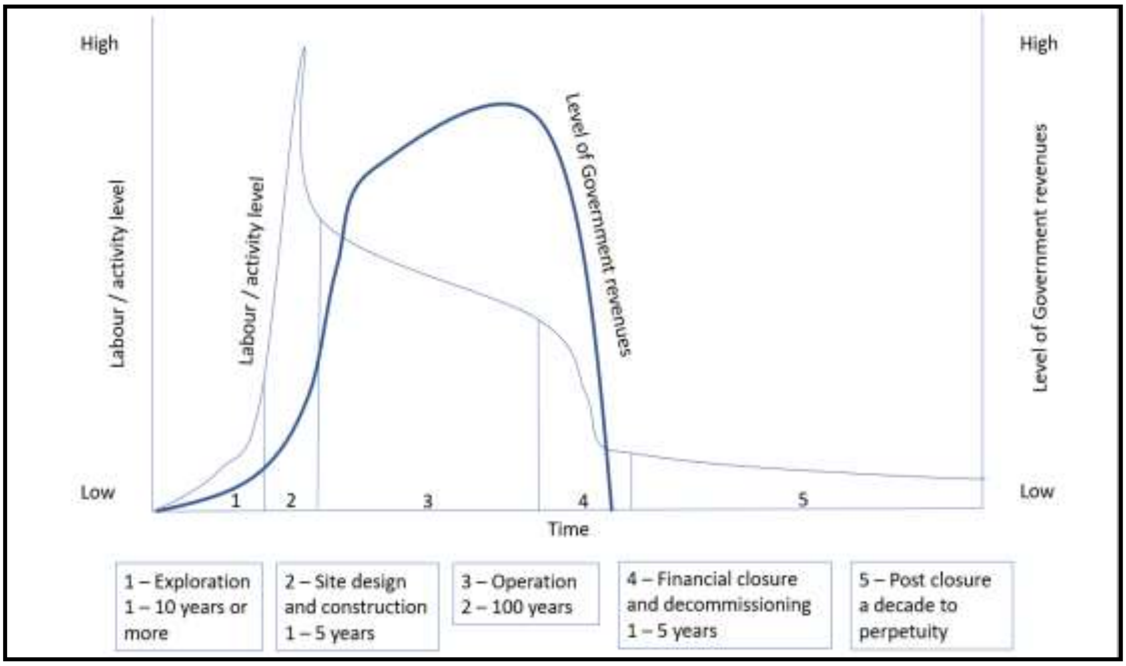
Figure 2.3 shows the typical mining project lifecycle, along with typical durations.



Source: KPMG International (2012:2)

Figure 2.3 – Typical Mining asset lifecycle.

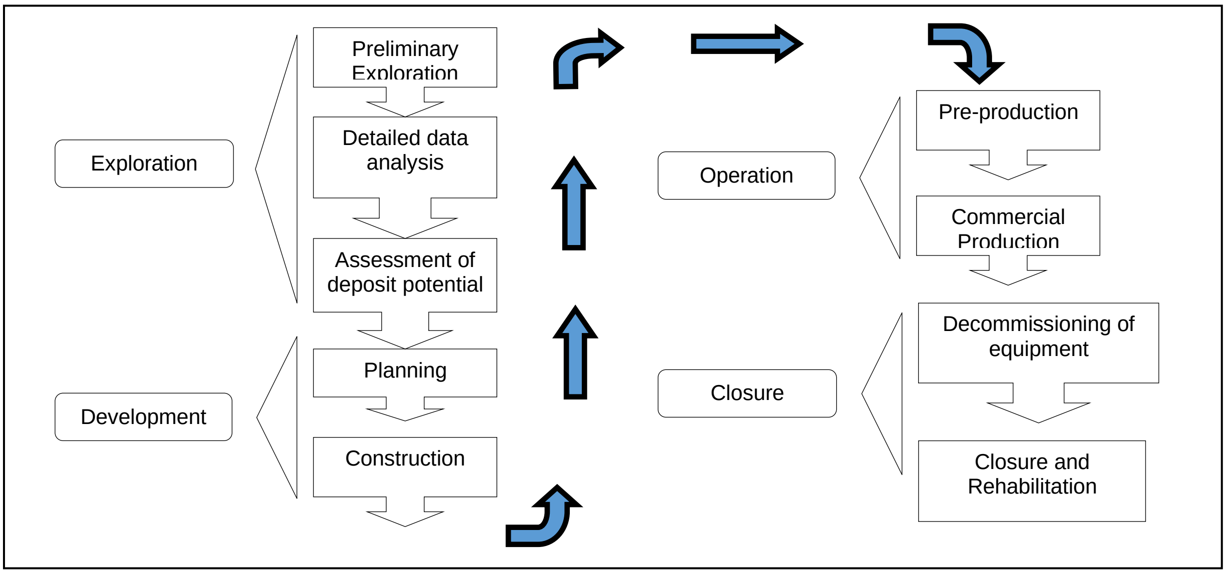
Figure 2.4 depicts the employment levels and government revenues over the lifecycle of a mine.



Source: ICMM (2018:32)

Figure 2.4 – Mining lifecycle

Badri, Nadeau and Gbodossou,(2012:146) note that all stages of a mining project have inherent risks and that different companies deal with these risks differently, depending on the responsibility and the risk tolerance levels of those involved. A typical mining project lifecycle, along with the activities in each stage, is illustrated in Figure 2.5.



Source: Badri et al. (2012:147)

Figure 2.5 – Lifecycle of a mining project

Rudenno (2012:378) points out that even in a mining project where significant geological exploration was carried out, a small change in the assumptions used in the techno–economic evaluation to predict the metallurgical yield and other mineral characteristics can have a significant impact on the eventual success of the project.

Rudenno (2012:21) notes that during a feasibility study on a mining project, the technical, as well as the financial aspects of a project, must be considered. Initially, the evaluation of the project can be qualitative, and decisions to proceed will be based on data and assumptions from similar projects. As more information becomes available through a more detailed exploration of the ore body, the grade and magnitude of the body can be better estimated. This additional information should assist decision–makers in determining the viability of a potential project. There is always a trade–off between capital cost, life–of–mine, and annual production rate. Also, each of these aspects influences decisions regarding the project. The annual production rate will influence the type and size of crushers, conveyors, and plant used during a project, which will in turn influence the capital cost. When the uncertainty regarding yield and other orebody characteristics are brought into the mix, the high degree of risk in mining projects becomes apparent (Rudenno, 2012:22).

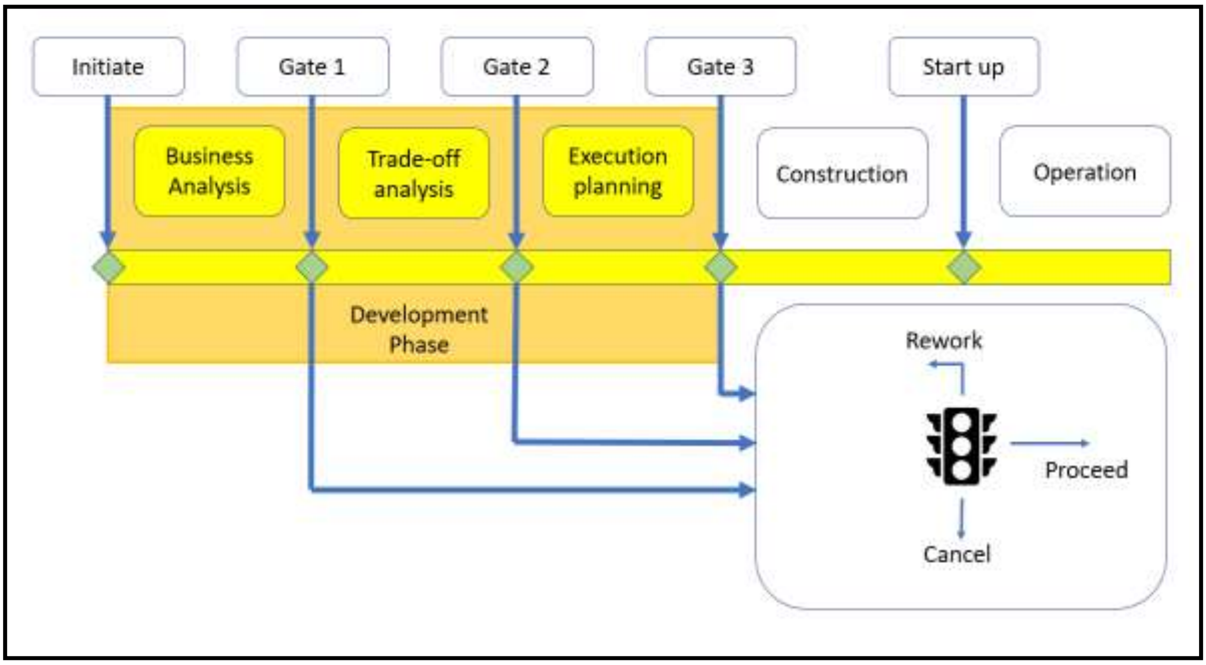
Other uncertainties mentioned by Rudenno (2012:23) include estimates of capital and operation costs, recovery and yield rates of ore, availability of water, power, transport, and infrastructure requirements, permitting, and environmental uncertainties. All of these contribute to risk in a mining project decision.

According to Kuhn and Visser (2014:106), decision–makers in mining projects are faced with a daunting task when deciding on project implementation. By applying appropriate risk management techniques (of which a mining RAT could be one), decision–makers could potentially ask the right questions and be in a better position to get the right answers. This could enable them to make the right project decisions. The typical manner in which front–end planning in mining projects is conducted is discussed in Section 2.7.1. The unique characteristics of a mining project front–end study are identified.

2.7.1 Front–end planning in mining projects

In the mining industry, the study of a project is often referred to as the front–end planning phase, the front–end loading phase, or the feasibility study. Rudenno (2012:36) notes that front–end planning provides the best estimate of an uncertain future. According to the Canadian Institute of Mining, a feasibility study is "a comprehensive study of a deposit in which all geological, engineering, operating, economic and other relevant factors are considered in sufficient detail that the results could reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production" (Persampieri, 2014:1). Kennedy (1990:393) states that feasibility studies, financial analysis and project financing are required to bring together all the data generated during a mining project study. Botin (2009:208) holds that the front–end planning phase of a mining project is a "Stepwise risk reduction process" where increasingly more substantial sums of capital are invested to minimise 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 2.6. One such approach is that of Anglo American, which divides this phase into resource planning, concept, pre–feasibility, and feasibility stages (Anglo American, 2009:14).

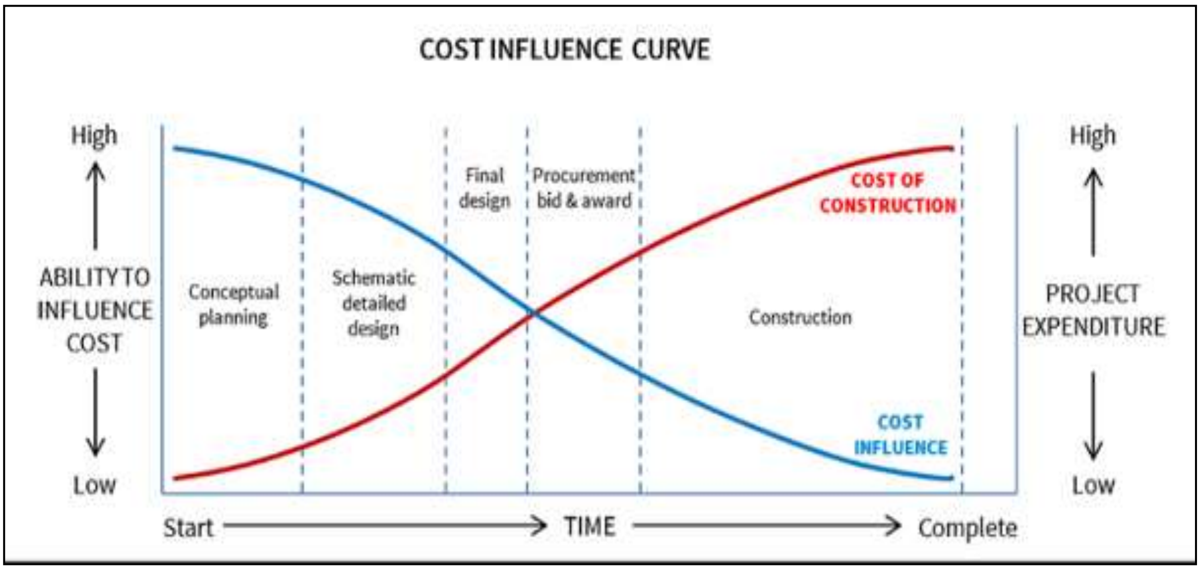


Source: Vasconcelos and Moraes (2010:2).

Figure 2.6 – Capital project lifecycle with gate reviews

As the study progress through the various stage–gates, the level of certainty of elements regarding cost, schedule, and engineering increases. Unless a tool such as the RAT is used to measure the level of definition which has been achieved, definition estimates are subjective, which makes it difficult for decision–makers to ascertain if the appropriate level of definition has been achieved to proceed to the next phase. Although several PDRIs have been developed for other industries, there is enough difference between mining projects and those in other industries, to necessitate a unique RAT for Mining Projects. These differences include the terminology used to describe the various elements, but also the categories and elements themselves, which differs from those used in the existing PDRIs.

According to Wittig (2013:392), 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 2.7 depicts this idea.

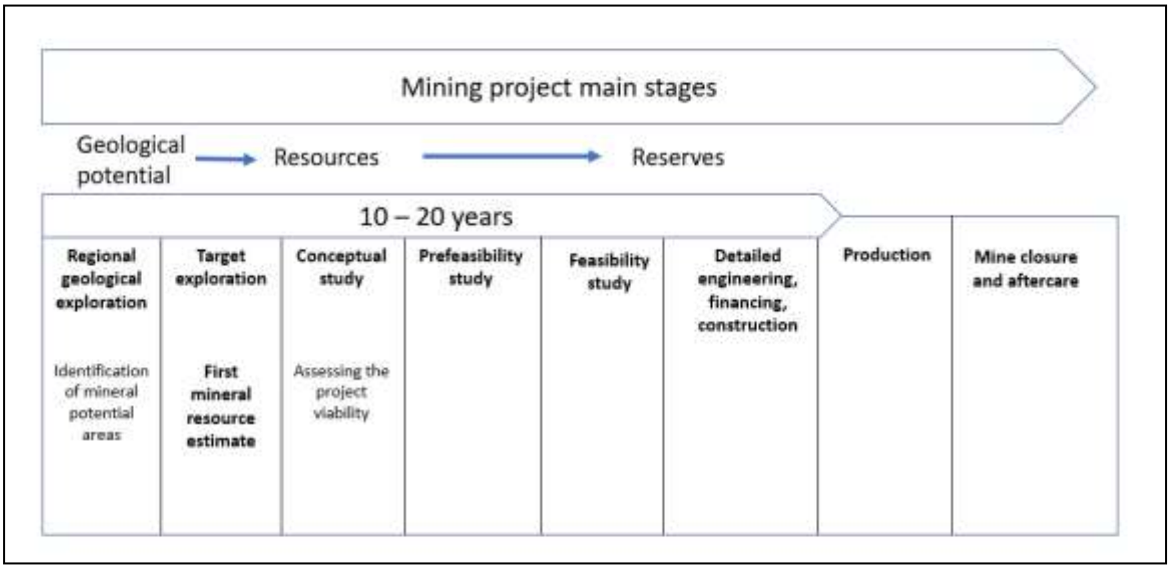


Source: Wittig (2013:392)

Figure 2.7 – The cost influence curve

Steffen et al. (2008:7) hold that the pre–concept phase of a project is becoming more critical, as a reliable resource development plan, aligned to the business strategy, is essential during this phase. When this is done well, the rest of the project evaluation process will proceed more smoothly.

The various phases of a mining project are depicted in Figure 2.8.



Source: Le Meur, Choconat, David, Geronimi and Samadi (2016:212)

Figure 2.8 – Mining project main stages

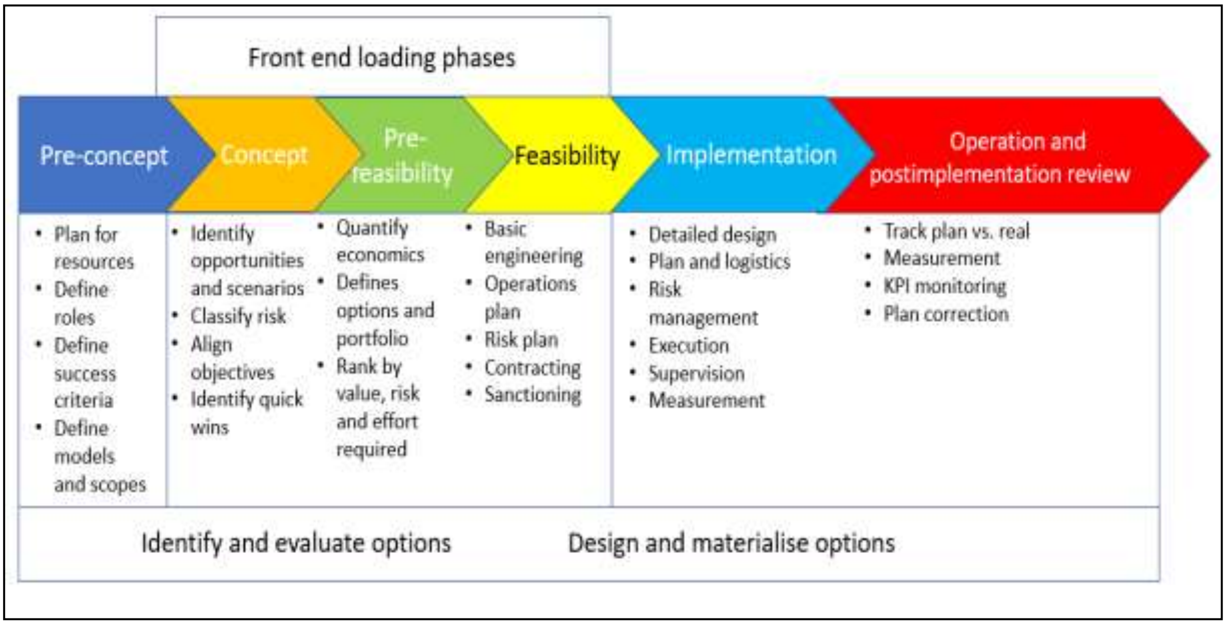
Cooper, Scott, and Kleinschmidt (2002:45) note that specialists review the project during each phase to evaluate its readiness to proceed to the next phase. Ireland (2008:41) highlights the importance of a stage–gate approach in mining project studies, as a tool to minimise risk and to give structure to a mining study. A typical mining project study in Australia, along with the stage/phase gates, is depicted in Table 2.5.

Table 2.5 – Typical stages / phase–gates in an Australian mining study

Stage		Mining phase–gate
1	Preliminary investigation	Does the area merit exploration funding?
2	Exploration licence application	Tenement grant or refusal
3	Exploration licence application	Discovery – yes or no
4	Feasibility study including assessment of mineral reserves	Does the proposal stack–up as a business venture?
5	Mining lease proposal prepared to support a mining lease application Process involves: – community consultation – description of environment – description of mining operations aspect and impact event identification and initial risk assessment, including stakeholder concerns development of control measures – residual risk assessment – outcomes to be achieved (including closure)	Does the proposal deliver a net public benefit? Tenement grant or refusal
6	Project control group established, including operational and other key resources Business plan developed, and finance sought	Going bankable
7	Mining and rehabilitation program (MARP) prepared Involves the same conceptual assessment process as a mining lease proposal as well as: – criteria to measure outcomes – measurement capability	Does the operator have a suitable management system? MARP grant or refusal
8	Detailed engineering and procurement	
9	Construction	
10	Business structure and processes for mine operation created	Further development
11	Mine operation	
12	Mine closure and rehabilitation	Have the closure criteria been satisfied, i.e. are there any legacy risks to government?
13	Lease surrender	

Source: Ireland (2008:40)

The main activities during the various front–end loading phases, as proposed by Steffen et al. (2008:6), are shown in Figure 2.9'.



Source: Steffen et al. (2008:6)

Figure 2.9 – Front–end loading project phases

Atkinson, Crawford, and Ward (2006:688) note that during the conceptual planning phase, there is little certainty about the future of the project and that this should be tolerated at this early phase. During the concept study phase, some alternatives which are considered as sub–optimal are eliminated from the study. The justification to proceed with the study is established during this phase. During this phase cost estimates are still vague. Industry standards and top–down approaches are used to establish the estimates for cost and time. As the project proceeds into the pre–feasibility phase, options are eliminated to arrive at a preferred method, based on the business case. The approach to estimating during this phase becomes more bottom–up (Wittig, 2013:394). This approach results in better quantifiable estimates and less allowance for contingencies.

During the feasibility phase, previous assumptions and designs are validated. The basis for the decision to proceed into detail design and implementation is established at this time. The basis of the funding and monitoring of the project, should it proceed, is also established during this phase. Typically, Value Improving Practices (VIPs) are implemented during this phase to improve the cost, time, and risk profile of the proposed project. VIPs are practices which aim to improve the scheduling, cost, or reliability performance of construction projects. These include process simplification, waste minimisation, 3d/4d design and lean manufacturing techniques. At the end of this phase, the project is submitted to a final stage review before being approved to proceed to detail engineering and implementation.

Pampieri (2004:2) notes that mining project studies are conducted using a series of assumptions which are based on test results or experimental information, using ore samples. The likelihood of inaccurate assumptions is high, due to:

- Samples not representing the ore body;
- Ore samples being inadequately or wrongly characterised regarding mineralogy or metallurgy;
- Test results were variable, leading to incorrect processing assumptions;
- Changes in marketing conditions during the implementation or operations of the project; and
- Costs (such as labour, supplies, energy) can vary from assumptions made during the study.

Pampieri (2004:4) notes that differences between assumptions made during the project study, and the actual performance of completed projects, are often the basis for disputes in mining projects. Pampieri (2004:7) advocates the use of a mechanism which ensures that all the participants in a project are aware of uncertainties at the time project approval.

O'Connor (2016:141) notes that not all projects are worth doing. In some cases, the company studying a project is not capable of executing the project, and sometimes it is better to sell a project to another company, which may be better equipped to execute the project. He adds that implementing the wrong project can destroy value, as can executing the right project poorly. Not doing a project which is right for the company, is a lost opportunity and destroys value. The proper tool to evaluate opportunities is required to make informed decisions.

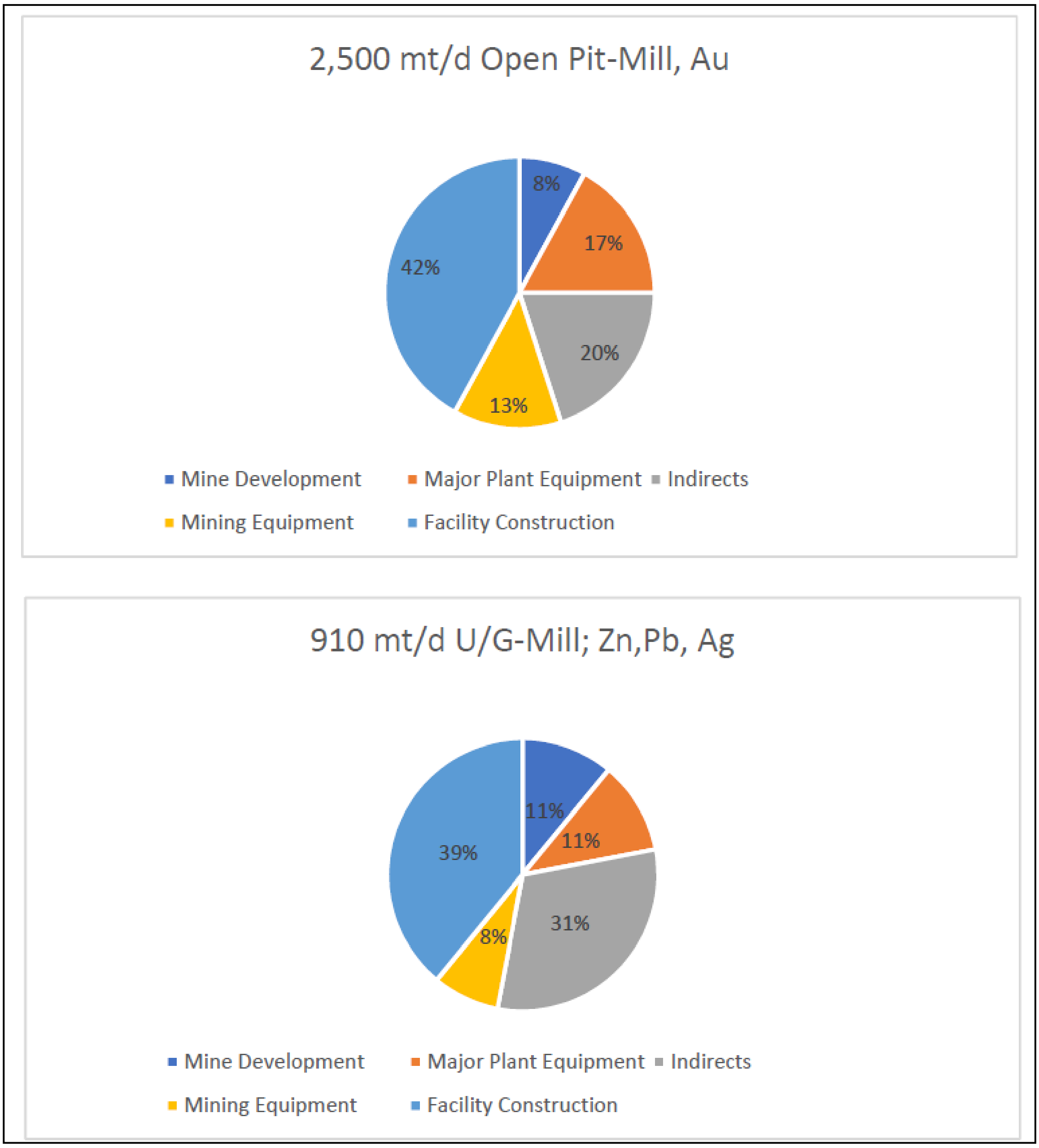
The CII, in the Pre–project planning handbook (1995:18), mentions that project costs are lowered while variability on costs, schedule and operating characteristics are also positively affected if the planning phase of a project is performed successfully. The CII also recognises front–end planning as a best practice which, if executed correctly, leads to enhanced project performance. Research conducted by the CII (Lotz, 2015:5). has indicated that adequately carried out front–end planning can:

- Reduce the design and implementation cost of a project by up to 20%;
- Shorten the design and construction schedule by up to 39%;
- Improve the predictability of project costs, schedule, and performance; and
- Increase the likelihood of a project meeting environmental and social expectations.

In Section 2.7.1 the unique nature of mining projects, specifically relating to studies, was highlighted, along with some of the benefits of conducting a proper study before proceeding to the implementation of the project. Some of the unique elements which should be considered during a mine project study are explored in the next section. These unique elements should typically form part of a front–end study evaluation for a mine project.

2.7.2 Elements to consider in mining projects

Gypton (2002:46) states that a mining project's scope is defined by the type of commodity, the production rate, the mining method (open pit, underground or a combination), and the degree of processing required (direct shipping ore, milling, smelting). Gypton (2002:42) notes that mining projects are made up of not only site infrastructure (which is usually not as well defined as the other major cost elements) but also mining and processing components. Figure 2.10 indicates the typical cost distribution of the various components of an open pit mine, as well as that of an underground mine.



Source: Gypton (2002:42)

Figure 2.10 – Typical cost distribution of components in a mine

Gypton (2002:43) notes that a lack of definition can result in inaccurate estimates of time and schedule. Gypton mentions that the lack of a clear link between capital expenditure and operational expenditure further exaggerates the inaccuracy of capital estimates. It is noted that support facilities such as warehousing and workshops are often not sufficient, as the impact of such infrastructure on operating cost is not adequately incorporated in the study. Gypton (2002:43) also notes the significant contribution (between 20% and 30% of the overall cost) of indirect costs to the overall project cost estimate. Indirect costs include the cost of:

- Engineering;
- Construction management;
- Permitting;
- Legal fees;
- Owner project management; and
- Facility commissioning.

Gypthon (2002:43) adds other factors which must be studied as thoroughly as possible to ensure project success. These include:

- The makeup of the owner's team to ensure adequate skills and experience;
- Sufficient participation by the project owner;
- Elimination of omissions and faulty assumptions which may affect the estimate;
- Identifying the logistics which will be used to supply the project during implementation, as well as the operations after the handover of the project;
- Staffing of the construction team with trained and skilled personnel;
- Planning for the funding of the project, including the financing cost and time required to secure funding;
- Addressing site–specific conditions; and
- Engineering to address the interpretation and evaluation of site–specific data.

Gypton (2002:44) advocates for addressing these elements thoroughly in the project study to ensure project success. According to Bakhtavar, Shahriar and Oraee (2009:486), many ore deposits have the potential to be mined as opencast mines or underground mines. The optimal depth to transition from open cast to underground mining or *vice versa* must form part of the life of mine (LOM) plan.

Park and Matunhire (2011:414) describe three distinct steps for mine evaluation, namely reserve evaluation, optimisation decisions and feasibility study. According to them, reserve evaluation involves all the steps between collecting samples by drilling, up to the calculation of the reserve. The optimisation phase encompasses the selection of suitable mining techniques for the specific orebody while calculating the optimum production rate and the life of mine plan. The risks associated with the project, such as political and environmental risks, are reviewed during the feasibility phase. During this stage, the economic analysis of the proposed funding model as well as the envisaged cash flow projection is carried out to determine the feasibility of the project.

Smith et al. (2008:337) mention two critical categories of planning, namely strategic mine planning, and tactical mine planning, which should be considered in a mining project. Each of these categories contains various elements. The strategic mine planning component deals with the long–term decisions and ensuring that all the value is exploited from the reserve. Components of strategic mine planning, mentioned by Smith et al. (2008:335), include:

- Exploration strategy;
- Extraction method;
- Mining sequence;
- Cut–off grade;
- The scale of operations;
- Metallurgical processing route;
- Social and labour plans;
- Environmental philosophy; and
- Sustainable development philosophy.

Tactical mine planning deals with the routine planning that is required to sustain the operations and implement new projects. These activities focus more on the short–term implementation of the long-term strategy and should not be detrimental to the long term strategic objectives of the company. Tactical planning includes:

- Budget preparation;
- Scheduling of production; and
- Process optimisation'.

Tactical planning is normally required due to changes in the external environment.

Accenture (2012) identified five critical areas for improvement in project delivery, all of which can be set up during the study phase:

- Establishing strong risk management and project governance capabilities;
- Addressing sustainability in project studies and implementation;
- Ensuring that talent is nurtured by addressing training, mentoring and flexibility in the design of the project organization;
- Ensuring that the requirements relating to the Information System are defined in the early stages of a project, to ensure integration between functional areas and service providers; and
- Ensuring the project is ready for handover to operations so that the plant or mine can operate at high production levels soon after the project is handed over.

Progue (2000:17) mentions numerous factors which must be considered during a mining project study. These include:

- Location, access, and climate;
- Ownership, mining leases, and other permits;
- Geology;
- Mineral resources and reserves;
- Mining methods and production levels;
- Beneficiation and metallurgical processing methods;
- Infrastructure;
- Health and safety;
- Environmental impact and management;
- Capital costs;
- Operating costs;
- Revenues;
- Cash flows and net present value;
- Management and staffing;
- Legal aspects of the company; and
- Financial structure.

Steffen et al. (2008:8) note the importance of incorporating contract management in the Front End Loading (FEL) study, and that it is essential to go to the market with a clear, concise, and complete tender document. It is also important that the legal and commercial aspects of the project delivery method be addressed during the study. The appropriate procurement strategy, based on the risks and opportunities associated with a project, can help the owner manage risk (Steffen et al., 2008:8).

Prieto (2015:24) is of the opinion that the relationships within a project, during project delivery and later during the operations of a facility, should be evaluated, and include the readiness of the owner's organisation as well as that of any joint venture partners for this type of relationship. Prieto (2015:26) also mentions that modularisation and standardisation are becoming more prevalent in complex projects. These may aid in shortening the delivery schedule of the project. Another factor which is essential in complex projects, according to Prieto (2015:39), is that the entire organisation, including the owner's board, investors and financing organisations need to be aligned to support the project. Prieto (2015:46) also advocates not only basing the design of the facility on engineering requirements (Engineering basis of design or EBOD), or even on a construction basis of design (CBOD), but also on an expanded basis of design (BOD^x), which also includes designing for operations and maintenance. Prieto (2015:47) points out that designing with all of these criteria in mind is different from trying to incorporate OandM and constructability later in the design phase.

Park and Matunhire (2011:415) point out some risks which should be considered when evaluating a mining project. These include:

- Technical risks;
- Reserve risks (distribution, grade, quantity, and quality of ore body);
- Completion risk (likelihood of cost overruns, construction delays and engineering or design flaws which may prevent the completion of the project);
- Production risks (the risk that production will not proceed as predicted due to equipment problems or problems with extraction processes or due to poor management);
- Economic risks;

- Price risks (variability in the future prices of commodities being mined);
- Demand risk (variability in demand for commodities, which will impact future prices and production);
- Foreign exchange risk (the impact on revenues and expenses due to fluctuation of exchange rates in countries where mines operate and sell their products);
- Political risks;
- Currency convertibility (freedom of capital transfer);
- Environmental risks (the effect of environmental legislation on costs, project timelines and unpredictability of government agencies);
- Taxation risks (variability in tax legislation and concessions); and
- Nationalisation.

Anderson *et al.*, Graham and Stubs (2000:1) adds violence and terrorism to political risks, noting that losses due to violence, as well as indirect costs in order to safeguard facilities, should be considered when evaluating an investment decision.

Marsh and McLennan (2015) mention various risks which should be considered when evaluating a mining project. These include:

- Labour and community relations;
- Terrorism and political violence;
- Political risks;
- Expropriation;
- Contract law;
- Currency convertibility; and
- Licence revocation.

Bruce (2014:5) mentions several environmental, social, and governmental risks which must be addressed during a mining project. The importance of the Social License to Operate (SLO) is stressed, and the negative impact on a mining project is highlighted, should the local communities become resistant to a firm's presence.

Bruce (2014:3) also notes some technical risks which must be addressed during a mining project study, and which can all be determined through detailed up–front work and investigations. These include:

- Geology;
- Ore Grade;
- Stability of excavations;
- Mineral recovery rates; and
- Pit designs

Financial risks, which can be mitigated through hedging, are also mentioned by Bruce (2014:3). These include price fluctuations and currency variations.

The Internation Council on Mining and Metals (ICMM), in its 2018 report on the role of mining in national economies (ICMM, 2018:3) mention that the degree to which a country is managed in order to create an enabling environment by collecting and spending taxation, is an essential enabler for mining projects. Unfortunately, 75% of those countries where mining plays a significant role in the economy, are noted by the ICMM as being governed at levels below what would be considered as appropriate for the good governance of mineral resources. The ICMM (2018:46) note that transparency is one component of good governance which is particularly important in mining projects. This includes transparency in contracts, ownership, and revenue payment.

Anderson *et al. et al.* (2000:3) points out that transportation risks could affect a mining project, as the infrastructure may not exist, or the availability could not be secure. Legal risk is another factor mentioned by Anderson *et al*. (2000:3) that is to be considered. The degree to which a host country would enforce contract law and the likelihood of litigation against a mining company should be considered when evaluating potential projects. Operational risks, such as the availability of materials and the flexibility of the marketplace is also mentioned by Anderson *et al.* (2000:7) as factors to consider while evaluating mining projects. Anderson *et al.* (2000:9) holds that labour risk could affect projects, as far as the likelihood of industrial action, as well as the availability of trained individuals, are concerned.

Anderson *et al.* (2000:9) postulates that risks in mining projects should also include the following:

- Health and safety risks – The extent to which the population can be trained to work safely;
- Infrastructure risk – The availability of electricity, water, and transport infrastructure, as well as whether the authorities will expect the mining company to develop infrastructure. The availability of spare parts and construction material form part of this risk; and
- Operational risk – The risk associated with technology becoming obsolete or adding unnecessary complexity to operations.

Dagdelen (2001:117) stresses that it is essential that the mine be designed to determine the optimal mining schedule which will result in the highest Net Present Value (NPV) while balancing production, blending, sequencing and pit slope stability. He notes that changes in commodity prices, costs and cut–off grades will affect the mine design.

Barnes, Hardwick, and Chan (2010:1) argue that there are numerous issues which influence the level of scoping for environmental assessment of mining projects. There are also best practices that will assist in improving the quality of decisions on proceeding with projects.

Barnes et al. (2010:1) also observed that scoping, as it relates to the environmental assessment, can be broken into three distinct activities, namely:

- Process determination (determining which laws and processes are applicable);
- Determining the scope of the project (what is the project which will be assessed); and
- The scope of the assessment (what will be studied, and how and to what extent it will be studied).

O'Faircheallaigh and Corbett (2005:630) mention that indigenous participation, both in environmental management of mining projects as well as achieving economic benefits for indigenous people, such as employment, monetary payments, training and business development opportunities, is essential. Prno and Slocombe (2012:347) continue that mineral developers need to ensure a 'social licence to operate' (SLO) in order to avoid social unrest. If this is not in place, Prno and Slocombe (2012:349) list some potentially negative results are listed by , including withdrawal of government permits, slow–downs and protests. Kirsch (2010:88) says that sustainability refers to more than just good environmental management. Instead, mining companies should focus on economic development that will last longer than the life of the mining project. The International Council on Mining and Metals (2018: 7) state that a finite resource, such as an ore reserve, cannot create sustainable development on its own, but can provide a number of stimuli to deliver sustainable development over the many decades in which it is usually exploited. These include mining procurement leading to new industries and activities, demand for non–mining resources due to higher incomes for local communities, new infrastructure which can be utilised for other uses, new skills developed through training by mines, and higher government spending on infrastructure and education due to royalties and taxes paid by mining companies.

Hillson and Murck (2000:229) note that the use of cleaner technologies helps minimize the adverse impact of mining projects, and may make the project more profitable in the long run. Less money has to be spent during the rehabilitation and closure of the mine.

Campbell (2011:2) advocates adopting a holistic approach to Corporate Social Responsibility (CSR), where the evolving regulatory framework is considered. 'Mining companies should consider the long–term effect of mining projects, instead of only focusing on the short term, investment–led perspective.

Stacey Naude, Hermanus and Frankel (2010:380) point to some concepts involved in mine closure planning, including the need to have a tailor–made plan for each mine closure. Planning for final land use is seen as critical, and should align with ecological, social, and political expectations. The mine closure plan should address health, safety, environmental, community and business risks. A mine closure plan should address policy requirements, stakeholder expectations, and developmental goals. Stacey et al. (2010:382) emphasise that mine closure should be built into all phases of the project life cycle and that mines should be designed, planned, and operated with the eventual end of life of the mine in mind. Social goals such as rehabilitating the mine to its optimum state after mining has ceased, should form part of the sustainability plan. Doing this during all phases should help prevent adverse impacts, eliminating the need to fix wrongs later. Maintaining a risk and opportunity register aimed at mine closure, as well as continuously consulting and empowering stakeholders throughout the project lifecycle and up to mine closure, is considered very important.

Stacey et al. (2010:383) state that it is essential to plan and make adequate provision for financial resources to complete eventual mine closure during the planning stages of a mining project. It is viewed as important to fix the goals and plans of mine closure during the planning stages of a mining project and continuously review these plans during the mine’s lifecycle. Du Plessis and Brent (2006:450) argue for the use of a risk–based model to calculate the cost of mine closure, considering master rates, quantities, and relevant escalation factors.

Hillson and Murck (2000:234) propose the formation of sustainability partnerships with academic groups, churches, non–profit organisations, government bodies and volunteer organisations. These partnerships or foundations which invest in sustainable development, help establish goodwill with local communities.

Some of the unique elements which pertain to mine projects were discussed in Section 2.7.2. These elements should be considered during a mine project study, to ensure that important information which may impact the performance of the project, is not missed. In section 2.7.3 the financial considerations regarding a mining project are discussed. Although this is one of the various elements which should be considered when evaluating a mine project study and was touched on in section 2.7.2, it is discussed separately in Section 2.7.3, as there are various aspects regarding financing which needs to be considered during the evaluation of a project study.

2.7.3 Financial considerations

Park and Matunhire (2011:413) note that due to the numerous risks in mining projects, the discount rate used during the economic evaluation has a significant effect on the outcome of the evaluation. They conclude that technical, economic and political aspects should be considered when deciding on the discount rate used in the calculation (Park and Matunhire, 2011:415) They also explain that because of the uncertainties regarding reserve estimates and quality, expected demand and ore prices over the life of mine and future costs and revenues, along with all the technical risks in mining projects, the appropriate discount rate must be used when carrying out the economic evaluation. They advocate calculating a risk rating for the project based on all the influences and then calculating a risk–adjusted discount rate for the project. In this way, investors can ensure that they are adequately compensating for the additional risk involved in projects. The risk premium must be calculated taking into consideration the macroeconomic circumstances, industry trends, strengths and weaknesses of the project, and other factors which could influence future cash flows and costs. The higher the perceived risk inherent in a project, the higher the expected returns should be.

Smith, Surujhlal and Manyuchi (2008:336) note that when evaluating mining projects, companies have to make a number of assumptions regarding exchange rates, inflation rates, metal prices, cost escalations, working capital and numerous other parameters which could impact the feasibility of a project significantly, as well as the impact of the parameters on each another. They advocate implementing scenario forecasting to compensate for the numerous combinations of potential outcomes.

Rudenno (2012:30) mentions that due to the relatively large capital costs of mining projects, mining companies are faced with difficult decisions when deciding on the funding models for new projects. While companies may be able to raise capital using their balance sheets, lenders often provide capital. Due to the gearing effect, shareholders will receive additional income if the commodity price rises above the estimated prices used in the economic evaluation. In the same way, shareholders will lose first if prices are lower than those used in the economic evaluation, while the lender will still receive interest. Rudenno (2012:31) also says that correct assumptions regarding cash flows during the project are important. Lenders are scrutinising the projected and actual cash flows during the project implementation phase, to determine the degree of risk, and thus the terms of the loan.

Cardin, Neufville and Kazakidis (2008:65) note that standard practices of appraising mining projects using one or a few constant prices for the product are insufficient. Commodity prices are highly variable and unpredictable over the life of mine. Although mining operators have flexibility in choosing the discount rates, incomes and expenses used during these appraisals, it usually does not account for the ability of mine management to change operations as prices and conditions change to maximise profits under prevailing conditions. It is proposed that even by implementing sensitivity analysis, where the evaluators attempt to account for varying prices and other uncertainties, the outcome is insufficient as it does not account for management's ability to change the operating plan to suit changing conditions. In order to address this shortcoming and better deal with uncertainty, it is suggested that instead of having a single operating or mining plan, a mining project should have a catalogue of operating plans, which covers the full spectrum of potential scenarios relating to prices and other variables. By implementing this method of project appraisal, it is estimated that better–informed decisions can be made which will deliver better returns and deal better with uncertainty. Del Castillo and Dimitrakopoulos (2014:208) refer to this technique as Real Options Analysis (ROA).

Del Castillo and Dimitrakopoulos (2014:207) argue that commodity prices and geology uncertainties are the most significant risk factors in new mining projects. Projects should be re–evaluated annually as these factors change. In addition, it is proposed that, when evaluating mining projects, the option to stop production or to accelerate operations should be built into the model to add better value. This helps optimise the design of the mine pit, and the location of infrastructure can be better planned to ensure that workshops and other infrastructure focus on the direction in which the mine is progressing. Similarly, leases and contracts can be designed to cater for variability.

Champigny, Lopez and Carter (2011:12) advocate for the implementation of a Capital Productivity Improvement (CPI) program, which creates value by ensuring that project scopes are optimised to create cost–effective solutions. A typical CPI will challenge existing project assumptions on three fronts, namely:

- The business case and investment proposal;
- The design of the process solution; and
- The design and cost of the engineering solution.

To implement the CPI, the use of internal engineering staff, as well as external content experts is suggested. The role of the internal experts is to generate and assist evaluation of improvement ideas, while the external experts challenge the internal thinking, ask the tough questions, and evaluate improvement ideas.

Ross (2018) highlights the importance of evaluating the “confrontational stance” of a government where mining projects are to be constructed, by referring to the mining code, royalties, and taxes imposed by governments, and the stability of these factors. The raising of royalties and taxes by the Democratic Republic of the Congo is noted as affecting the viability of some mining ventures in the country. Dash (2018) blames Indian mining legislation for a fall in Foreign Direct Investment (FDI) in Indian mining from US$ 659 million in 2015 to US$ 36 million in 2018. High taxes and a mineral exploration and licensing policy which does not guarantee an investor the right to prospect and mine, are blamed for this fall in FDI.

A study in Brazil (Motta, Quelhas, Filho, Franca and Meirino 2014:402) found that 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). No non–proprietary tools exist in the industry for the evaluation of Scope Definition before implementation (Gibson and Dumont, 1996:14 and Motta et al., 2014:411).

In Section 2.7, mining projects were examined to identify the unique characteristics of mining projects. The manner in which front–end planning is done in the mining industry was explored in Section 2.7.1, and a number of the elements to be considered during a mine project study were examined in Section 2.7.2 and 2.7.3.

Mining projects are clearly unique. A separate tool should be developed to assess the readiness of mine project studies to proceed into detail design and implementation. Sections 2.5 and 2.6 discuss other tools in the industry which can be used to evaluate a mine project study, along with the CII PDRI suite of tools.

2.8 Summary

In this chapter, the concept of megaprojects was explored, due to the fact that many mining projects (because of the scale and complexity) fall into this category. In order to understand megaprojects better, the performance of megaprojects was investigated, along with the reasons which lead to failure of these projects. The concept of Front–end Planning was also explored, to highlight the contribution thereof to project success.

The various current Readiness Assessment Tools which are available were explored, to determine if any of the existing tools cater for the unique requirements of a mining project. It was illustrated that none of the existing, freely available tools cater for all the characteristics of a mining project, and that the CII's set of PDRIs, although not specifically designed for mining projects, was the most commonly used, freely available and well known tools in the industry. It was therefore decided to base the development of a Readiness Assessment Tool for Mining Projects, upon the methods and framework of the existing PDRIs which were developed by the CII prior to 2017, when this study began.

While examining the features of mining projects, a number of unique factors were identified, which should form part of a Readiness Assessment Tool. These included the fact that the exploration which feeds into the geological model, should be considered during the front end planning phase, as this feeds into the estimates of the reserve, and also influences the Life of Mine planning, including important decisions such as the type of mining activities (open pit versus underground). It was also found that mines are often constructed in remote areas, and a mining project must not only cater for the infrastructure on the mine, but also for the associated infrastructure which is required to refine the ore, or at the very least to transport the ore to often remote ports or clients. The off–site infrastructure required for power, water, sewerage, and accommodation also needs to be considered due to the remote nature of mining projects.

Other important elements for the front–end planning phase of a mining project that emerged in this chapter, included the political, environmental and legal risks associated with the country or region where the mine is to be constructed. Added to this are the various metallurgical processing options and the planning for the eventual closure of the mine, which should be considered during the front–end planning phase.

While elements of the above–mentioned factors are included in some of the existing PDRIs, no single PDRI caters for all of these, and there are several elements that are not addressed in any of the existing PDRIs.

The conceptual model of the study will be discussed in the next chapter.

3. CONCEPTUAL MODEL

In the preceding chapter, a literature review was conducted to highlight the importance of conducting a proper project study before proceeding to project implementation. The various phases of a project study were discussed, and the tools which are currently used for this purpose were examined, along with the shortcomings of these tools. The importance of project assessment tools for improving project definition were reviewed, as were tools available in literature and in the market. For the purpose of this study, the PDRI approach developed by CII was selected as th basis for the development of a Readiness Assessment Tool for Mining Projects. In this chapter, the conceptual model, or framework for the study, is discussed.

3.1 Exploring conceptual model theory

According to Bond–Barnard (2018:12), the conceptual model is the analytical framework for a study. It is the link between the literature study (which was conducted in Chapter 2) and the research design (which will be discussed in Chapter 4) and forms the basis for the definition of the research questionnaire. A conceptual framework or model assists a researcher by providing a visual representation of the theoretical constructs (Stanford, 2018:1). According to Goes (2011:6), concepts are abstract elements representing classes of phenomena in a field of study, whereas variables are concepts stated in measurable terms, and thus more specific than concepts. A concept thus consists of, or is influenced by, some variables. The conceptual model is a graphical illustration of the link between variables and a concept (or theory). According to Govender (2018:6), a conceptual framework is the "system of concepts, assumptions, expectations, beliefs and theories that supports and informs your research and the relationship between them." Saunders, Gray, Tosey and Sadler–Smith (2015:37) add that a concept is the mental image or abstraction of a phenomenon, and those concepts can be combined into a conceptual model or framework. According to Saunders et al. (2015:37), a conceptual framework illustrates how the concepts and information which is relevant to the research are likely to be connected. In this way, a conceptual model provides a guide on which theory can be built. Whereas the conceptual model looks purely at the visual representation of the concepts and the links between them, a conceptual framework also considers the ontological and epistemological assumptions and previous research upon which the model is built (Saunders et al. 2015:37). For this reason, the ontology and epistemology related to this study are discussed in Chapter 4.

3.2 The RAT for Mining Projects conceptual model

During the literature review, the reasons for conducting a thorough study before proceeding into project implement were highlighted. The various existing models to evaluate the maturity of a project study were investigated, along with the existing PDRIs which have been developed in other industries. The study to compile a RAT for Mining Projects was based on the methodology which was followed in the development of the previous PDRIs. The various elements which are unique to a mining project, and which should be considered when conducting a mining project study, were also explored. It was clear from the studies which were conducted to establish the previous PDRIs for other industries, that the maturity of the study at the time of project approval, was not the only determinant of project success. Therefore, the degree of maturity of a project study would not be able to predict all the variability relating to the success of a project. This concept is illustrated in Figure 3.1.

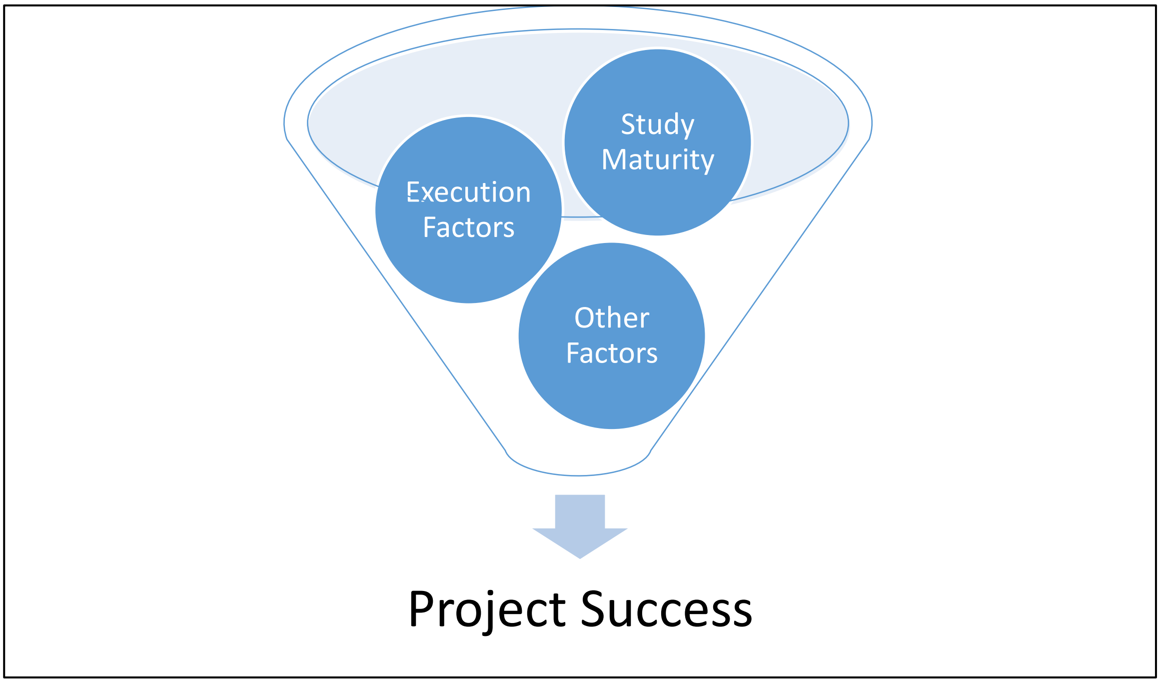


Figure 3.1 – Factors influencing project success

Although there are other factors which influence the success of a project, there are numerous sources in the literature, explored in Chapter 2, which indicate that the maturity and thoroughness of a project study could significantly impact the outcome of a project. A number of sources had to be consulted to establish a draft list of elements to be considered during a mining project study. These include the previous PDRIs (to establish if there are any common elements with any of the previous PDRIs) and a review of the existing literature. This process is illustrated in Figure 3.2.

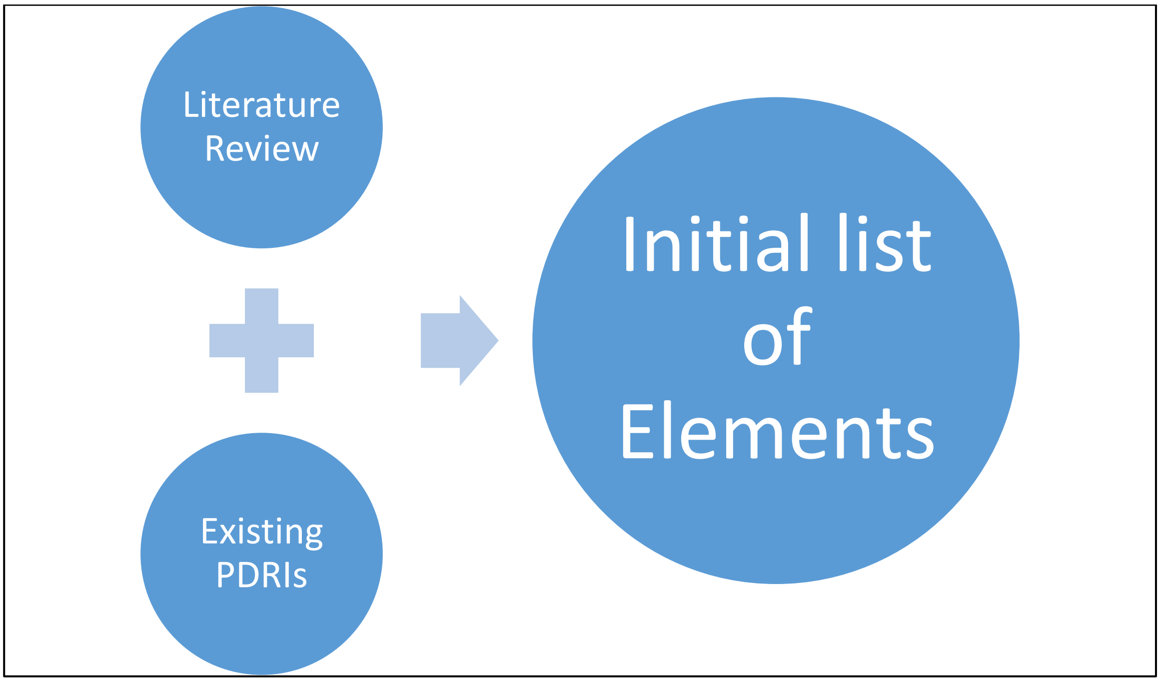


Figure 3.2 – Compiling an initial list of elements applicable to a mining project study

The initial list of elements applicable to mining project studies, which was compiled from the literature review and by evaluating the existing PDRIs, is depicted in Annexure A. Apart from providing a list of elements applicable to mining project studies, the list also divides the elements into categories and sections. This first division into categories and sections was based on the previous PDRIs. This is illustrated in Figure 3.3

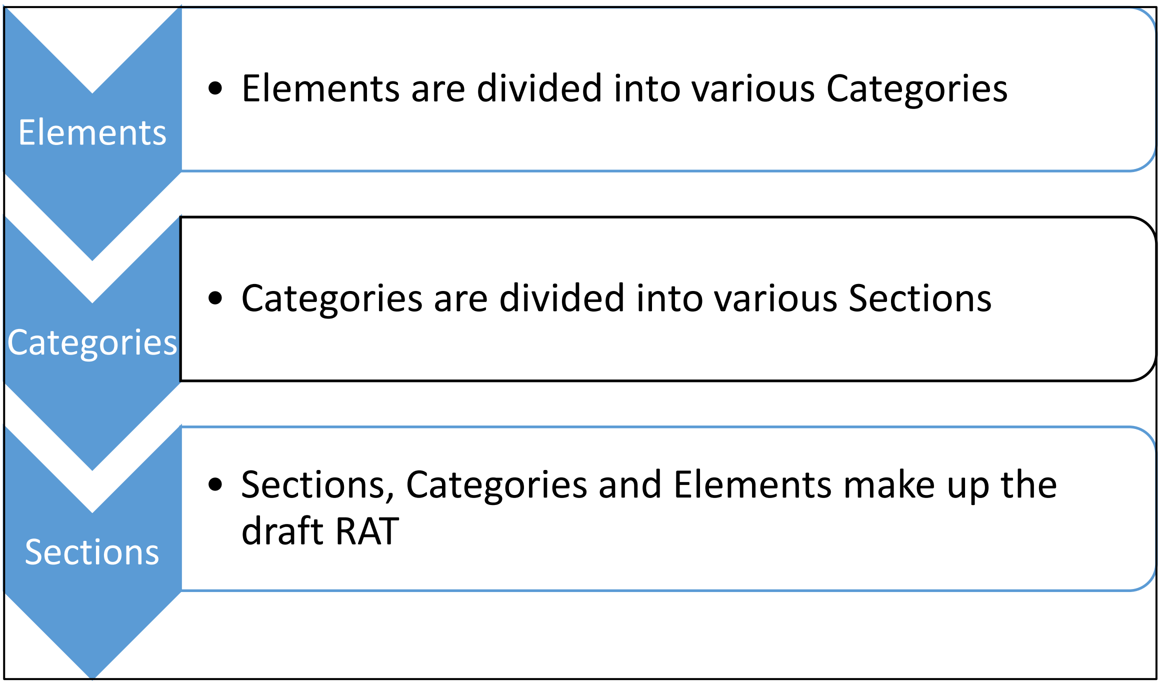


Figure 3.3 – Illustration of the link between Elements, Categories and Sections

Together, the sections, categories and elements equate to the draft RAT for Mining Projects, which will be further tested before becoming the final unweighted RAT for Mining Projects.

The initial list of Sections, Categories and Elements comprises three Sections (Similar to previous PDRIs). The First Section – Basis of Project Decision – is made up of 8 Categories. These are:

a) Business Strategy,
b) Reserve Calculation,
c) Production Method and Capacity,
d) Revenue Generation,
e) Project Considerations,
f) Project Scope,
g) Value Improving Practices, and
h) Mine Closure Plan

An example of the way the Elements and Categories feeds into Sections, is given in Figure 3.4, which shows how Categories B and F and their respective Elements contributes to Section I. The full breakdown of Sections, Categories and Elements in the Draft unweighted RAT is shown in Annexure A.

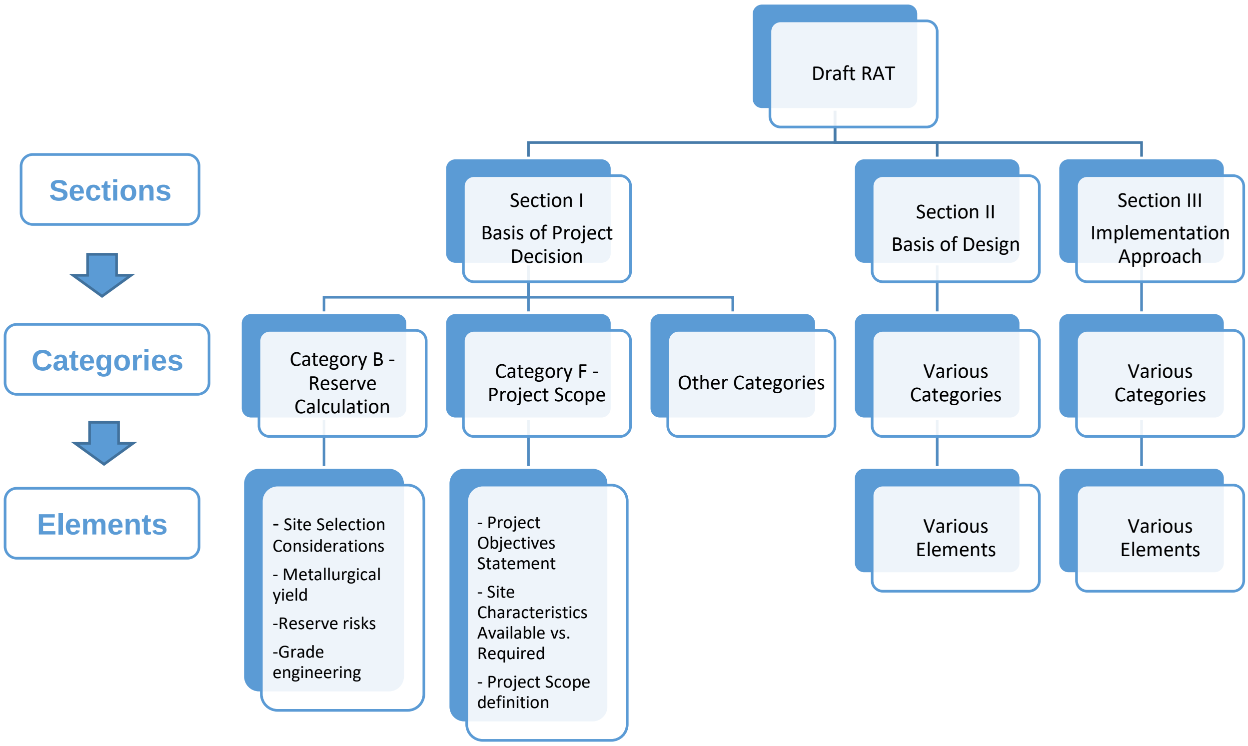


Figure 3.4 – Illustration of the manner in which the Elements of Category B and Category F roll up into Section I

The conceptual model for this study is thus a graphical depiction of the way the sections and categories result in the draft unweighted RAT. This model is depicted in Figure 3.5.

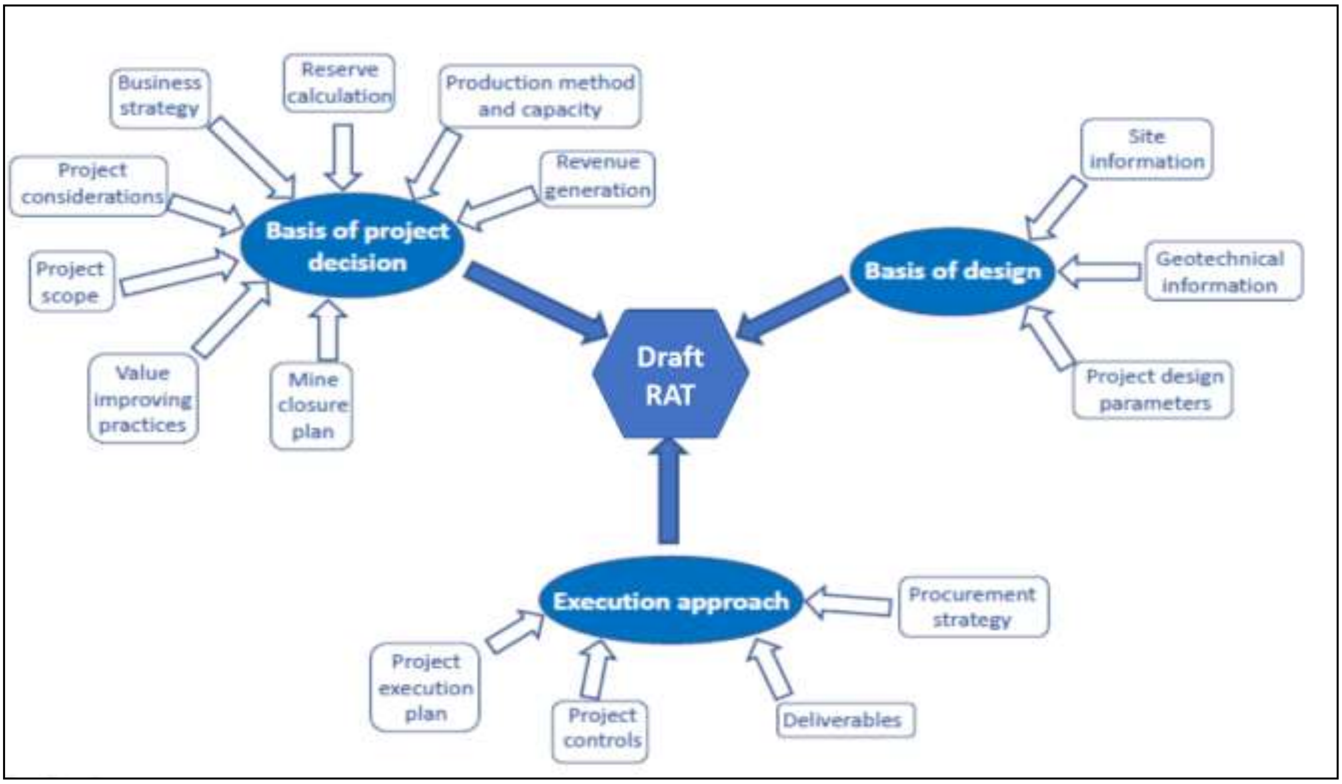


Figure 3.5 – Conceptual model indicating how individual categories and sections influence the draft RAT for Mining Projects

This draft RAT for Mining Projects formed the basis for the establishment of the final unweighted RAT for Mining Projects. The approach followed in compiling the final RAT for Mining Projects is described in Chapter 4, which deals with the research methodology.

3.3 Summary

In this chapter, the importance of a conceptual model in a research project was identified. The factors which influence the success of a project were graphically illustrated, along with the way the draft list of elements in the RAT for Mining Projects was compiled. Following this, the conceptual model for the draft RAT for Mining Projects was developed. This model was based on three Sections and 15 Categories. The full list of Sections, Categories and Elements are given in Annexure A. The conceptual model will be used as the basis of developing the final RAT for Mining Projects. This process is elaborated on in the next chapter.

4. RESEARCH METHODOLOGY

In the preceding chapter, the importance of a conceptual model in bridging the literature review and research design was investigated. The conceptual model for the RAT for Mining Projects was developed, by considering the draft RAT for Mining Projects, and the way it was developed.

In this chapter, the research method is discussed. Due to the qualitative and quantitative nature of this study, the mixed–method research will be explored, including how it is applied in the research design. Following this, the approach followed during previous PDRI research projects and how it is applied in this research will be explained.

4.1 The research paradigm

According to Kuhn (1970:175), a *research paradigm* is “the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community”, and that “Men whose research is based on shared paradigms are committed to the same rules and standards for scientific practice” (Kuhn, 1970:23). Kuhn (1970:24) further states that transition from one paradigm to another via revolution is a typical developmental pattern of mature science. Kuhn goes on to add that, to be accepted as a paradigm, a theory must seem to be better than the competing theories but does not necessarily have to explain all the facts it can be confronted with (Kuhn, 1970:30). A paradigm can thus be viewed as the widely accepted theory, held by a group of practitioners or community, that suggests which experiments would be worth performing, and which would not. (Kuhn, 1970:30).

Patel (2015:1) notes that there are five main paradigms regarding research, namely Positivism, Constructivism, Pragmatism, Subjectivism and Critical.

- Positivists believe that there is one reality which can be measured and are, therefore, more inclined to follow a quantitative research methodology to measure this reality;
- Constructivists believe that there is not a single reality or truth, but that reality needs to be interpreted, and are therefore more prone to using qualitative research methods;

- Pragmatists believe that reality is fluid, and needs to be debated, negotiated, and interpreted and that the best research method to use, depends on the problem which needs to be addressed;

- Subjectivists believe that reality is whatever we believe to be real, and will make use of specific methods, such as autoethnography, semiotics, literary analysis, and intertextuality; and

- Criticists believe that realities are socially constructed entities which are under constant internal influence. They will tend to use ideological reviews, open–ended interviews, focus groups, open–ended questionnaires, and open–ended observations to conduct research.

This research leans towards the Pragmatic paradigm, as the research methodology has been adapted to suit the specific problem which needs to be addressed. By combining qualitative and quantitative research, this study followed a Mixed Method approach, combining qualitative and quantitative research, to identify the various elements which are applicable, and then assigning weights to the various elements and testing the completed tool through a validation process. Kaushik and Walsh (2109: 255) note that Pragmatism embraces plurality of methods and is often associated with Mixed Method Research (MMR). Kaushik and Walsh (2109: 259) note that Pragmatists will consider the problem, and then decide on the most applicable method to solve the problem.

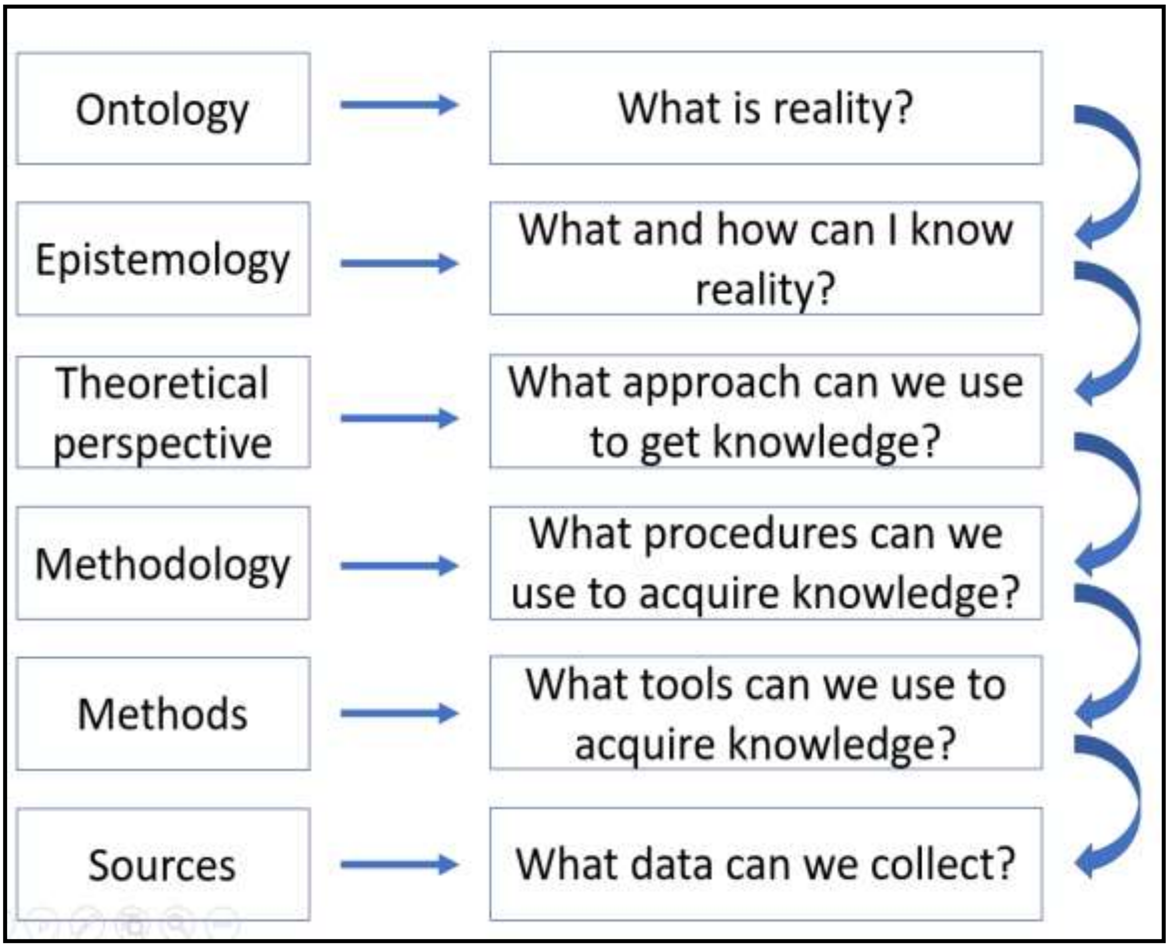
4.2 Ontology

Jepsen (2009:22) explains that *ontology* is a method of representing items of knowledge (facts, ideas, concepts) in a manner that defines the relationships within a specific domain of knowledge. Hodgon (1999:16) states that the ontology of a profession encompasses the set of words, relationships, and meanings that describes the philosophy of the profession. Hodgon (1999:16) further states that professionals in a specific discipline face the risk of being considered as unprofessional or inexperienced if the ontology of the discipline is not adhered to. The practitioner may for instance not use the terms and definitions which are widely recognized in the Body of Knowledge (BoK) of the discipline. Patel (2015:1) notes that there are various views regarding ontology in the research community, that are based on the paradigm that a researcher ascribes to, but that in essence, the ontology of a specific group represents their view of what reality is.

4.3 Epistemology

Goldman (1938:2) states that epistemology is the study of methodology and that epistemologists are interested in whether beliefs about the world are warranted. Epistemologists seek to discover or invent proper methods of investigation or inquiry. The manner in which researchers prefer to conduct research (their epistemology) is thus closely interrelated with the researcher's research paradigm. The paradigm that a researcher subscribes to will dictate the epistemological approach which the researcher will prefer.

Patel (2015:1) illustrates the various terms and the relationship between them, as indicated in Figure 4.1.



Source: Patel (2015:1)

Figure 4. 1 – Relationship between research paradigm terms

4.4 Developing the research strategy

Patel (2015:1) compares the various paradigms, as illustrated in Table 4.1. The table indicates the five main research paradigms and compares the ontology, epistemology, theoretical perspective, methodology and methods associated with each paradigm.

Table 4. 1 – Comparison of paradigms

		Ontology	**Epistemology**	**Theoretical perspective**
Paradigm		*What is reality?*	*How can I know reality?*	*Which approach do you use to know something?*
	Positivism	There is a single reality or truth (more realist)	Reality can be measured, and hence the focus is on reliable and valid tools to obtain that	Positivism Post–positivism
	Constructivist / Interpretive	There is no single reality or truth. Reality is created by individuals in groups (Less realist)	Therefore, reality needs to be interpreted. It is used to discover the underlying meaning of events and activities	Interpretivism (reality needs to be interpreted) Phenomenology Symbolic interactionism Hermeneutics Cultural inquiry Feminism
	Pragmatism	Reality is continuously renegotiated, debated, interpreted in light of its usefulness in new unpredictable situations	The best method is one that involves problems. Finding out is the means, change is the underlying aim	Deweyan pragmatism Research through design
	Subjectivism	Reality is what we perceive to be real	All knowledge is purely a matter of perspective	Postmodernism Structuralism Post–structuralism
	Critical	Realities are socially constructed entities that are under constant internal influence	Reality and knowledge are both socially constructed and influenced by power relations	Marxism Queer theory Feminism

		Methodology	Method
		How do you go about finding out?	*What techniques do you use to find out?*
Paradigm	Positivism	Experimental research Survey research	Usually quantitative, could include: Sampling Measurement and scaling Statistical analysis Questionnaire Focus group Interview
	Constructivist / Interpretive	Ethnography Grounded theory Phenomenological research Heuristic inquiry Action research Discourse analysis Feminist standpoint research	Usually qualitative, could include: Qualitative interview Observation Participant Non–participant Case study Life history Narrative Theme identification
	Pragmatism	Mixed–methods Design–based research Action research	Combination of any of the above and more such as data mine expert review, usability testing, a physical prototype
	Subjectivism	Discourse theory Archaeology Genealogy Deconstruction	Autoethnography Semiotics Literary analysis Pastiche Intertextuality
	Critical	Critical discourse analysis Critical ethnography Action research Ideology Critique	Ideological review Civil actions Open–ended interviews, focus groups, open–ended questionnaires, open–ended observations, journals

Source: Patel (2015:1)

As mentioned in Section 4.1, this study leans towards the Pragmatism paradigm. Typically, this type of study will follow a mixed method methodology, in which methods can be combined, and qualitative and quantitative methods are not seen as mutually exclusive.

4.5 Research Design

Although the process to establish a PDRI has been refined during the studies to establish the previous PDRI tools, each of the previous studies followed a slightly different path. According to Singh (2007:64) "exploratory research is the initial research, which forms the basis of more conclusive research. It can even help in determining the research design, sampling methodology and data collection method." According to Brown (2006:43), exploratory research is usually used to investigate problems for which little research has been done. While exploratory research results in a range of causes and potential solutions, conclusive research aims to identify a single solution to a research problem. The initial portions of the studies were all exploratory in nature and intended to develop a draft, unweighted list of elements which should be considered during the front–end planning phase of a project.

As can be seen from the previous chapter, there are various models to evaluate project studies, but no single, widely accepted model to evaluate mining project studies. The initial portion of this study is thus exploratory, as the elements which are unique and specific to mining project studies are explored during this phase. Exploratory studies may have a less rigorous methodology than conclusive studies, and sample sizes may be smaller (Nargundkar and Prietsley, 2003:41). It is, however, essential to conduct the study in a methodological way, as it will form the basis of more conclusive research. Typically, once an exploratory study has been undertaken to establish a potential solution to the research question, follow–on studies can be undertaken to bring the final solution closer to a single solution for the research problem.

One of the advantages of an exploratory study, according to Dudovskiy (2018:43) is flexibility and the ability to change the research approach. Exploratory studies are associated with qualitative methods, such as literature reviews, interviews and focus groups.

Following the exploratory portion of the study, in which the problem is investigated, a more conclusive research design approach was followed. According to Dudovskiy (2018:77), conclusive research designs are used to quantify or verify findings of exploratory research. While the initial, exploratory portion of this study was used to identify the various elements which must be addressed in a mining project study, the later, conclusive part of the study was used to quantify and verify the applicability of the various elements. Conclusive methods are associated with quantitative methods of data collection and analysis (Dudovskiy, 2008:79). Exploratory and Conclusive research designs are compared in Table 4.2.

Table 4. 2 – Comparison of Conclusive and Exploratory research designs

Factor	Conclusive	Exploratory
Objectives	To test hypothesis and relationships	To get insights and understand
Characteristics	Information needs clearly defined The research process is formal and structured Large representative sample Data analysis is quantitative	Information needs are loosely defined The research process is unstructured and flexible Small, non–representative sample Primary data analysis is qualitative
Findings	Conclusive	Only tentative
Outcome	Findings used as input to decision making	Generally followed by further exploratory conclusive research

Source: Research Methodology.net

Following a Pragmatic approach (where the end justifies the means) and combining various methods to get to the best solution, this study starts off as an exploratory study and then progresses to a more conclusive research design. In the exploratory portion, the objective is to identify the various elements which should be considered during a mining project front end planning phase, and to set up the broad framework for a RAT for Mining Projects. The sample size in this portion is relatively small and the findings are tentative. The research was mainly based on qualitative methods. Following the creation of a draft unweighted RAT for Mining Projects, a more structured approach was followed during the Conclusive research design phase. In this phase, the research process was more formal and structured, the sample size was larger, and the data analysis was quantitative.

4.6 The mixed–method approach

When qualitative and quantitative methods are combined in a study, the result is a mixed–method research (MMR) approach to research design. According to

Hammersley (1996:167), mixed–methods research is employed for the broad purpose of breadth and depth of understanding and corroboration. Denzin and Lincoln (2011:286) add that by using a mixed–method research design, the researcher can choose the best approach from a range of sources, systems and styles by incorporating and integrating the most appropriate techniques from qualitative and quantitative styles, to investigate the topic of interest more thoroughly.

4.6.1 Background

According to Denzin and Lincoln (2011:286), the mixed–method research approach emerged in the social and behavioural sciences in the 1970s. It involved adding a qualitative component to a quantitative study, to make more sense of the numbers. This meant that the question of why and how a program failed (the formative component) could be answered, along with whether a program worked (the summative component). Denzin and Lincoln (2011:286) are careful to explain that qualitative methods are not superior to quantitative methods, or *vice versa*, but that a mixed–method approach can add value by examining issues in ways that qualitative or quantitative methods alone cannot. Newman, Ridenour, Newman, and DeMarco (2003:170) emphasise that the research question dictates the selection of the research method.

Johnson, Onwuegbuzie and Turner (2007:114) note that triangulation is the "combination of methodologies in the study of the same phenomenon." Four types of triangulation are mentioned by Johnson et al. (2007:114), namely:

- Data triangulation – using various sources in a study;
- Investigator triangulation – using different researchers in a study;
- Theory triangulation – using various perspectives and theories to interpret the results; and
- Methodological triangulation – using multiple research methods to study a problem.

Denzin (1978:291) further distinguishes between *within–methods* and *between–methods*. Within–methods refers to using either multiple qualitative or quantitative methods. Between–methods refer to using both qualitative and quantitative approaches in one study. Denzin (1978:293) notes that the between–methodology should be used when possible, as it will ensure that the bias present in any data source is cancelled out when used in conjunction with other sources, investigators, and methods. Jick (1979:607) adds that using triangulation can lead to thicker, more abundant data than when utilising only one type of data gathering method.

Johnson et al. (2007:132) distinguish between mixed–method research, which combines qualitative and quantitative methods, and multi–method research, which utilises two methods from the same paradigm (such as surveys and records, or interviews and focus groups).

Halcomb and Hickman (2015:49) note several reasons for using a mixed–method research design. These are:

- Corroboration: the results of the findings using a specific method, is corroborated by the results of a finding, using another method.
- Complementarity: the use of one method to elaborate or clarify the results of another method.
- Development: the findings from one method inform the results of another method. This can include instrument development, where qualitative methods are used to design a quantitative instrument.
- Sampling, where one approach facilitates sampling for another approach.
- Initiation: One method is used to explain the apparent paradoxes in the findings from another method.
- Expansion: the depth and breadth of the study are expanded by combining the various methods.

The development of the RAT tools is an Instrument Development process, and according to the abovementioned definition, this research lends itself to the MMR approach.

Sieber (1973:1351) provides numerous reasons for combining qualitative and quantitative research. One of these is that quantitative data can help identify representative samples for the qualitative component of the research and *vice versa*.

4.6.2 Criticism of the mixed–method approach

While many researchers (especially in the social and behavioural sciences) have accepted the compatibility thesis, which states that qualitative and quantitative methods of research can co–exist in the same study, there are those who believe their own orientation to be superior (Johnson and Onwuegbuzie, 2004:100). In particular, proponents of either qualitative or quantitative research are noted by Johnson and Onwuegbuzie (2004:111) as being less supportive of MMR designs. A critique of MMR held by proponents of qualitative research especially is that MMR does not employ critical, interpretive approaches to qualitative research (Johnson and Onwuegbuzie, 2004:111). This critique is, however, refuted by Creswell, Shoppe, Planno and Greene (2006:10) who provide evidence of the use of interpretive frameworks in several MMR studies.

Denzin and Lincoln (2005:9) note that MMR excludes stakeholders from dialogue and active participation in the research process, but this is refuted by Teddlie and Tashakorri (2009: 103), who note several MMR studies which were participatory in nature.

4.6.3 The epistemological approach towards the mixed–method design

Howe (1988:10), a proponent of the compatibility thesis, is if the opinion that combining qualitative and quantitative methods creates value and that the “wedding” of such methods is not epistemologically incoherent. Howe further explains that pragmatism is an alternative paradigm, which supports the use of a mixed–method approach. This view has been supported by numerous researchers, such as Johnson and Onwuegbuzie (2004:23), Maxcy (2003:19) and Tashakkori and Teddlie (1998:55). Denzin and Lincoln (2011:287) call Mixed–Method Research (MMR) a “big tent” in which researchers who use MMR come from a variety of philosophical orientations, such as pragmatism, critical theory, and the dialectic stance. MMR emergence partially from triangulation theory (Patton, 2002:18) and is often associated with the convergence of results from many sources. However, Tashakkori and Teddlie (2008:169) point out that combining information from various sources often leads to divergence, which can provide additional insight into a specific problem. Newman, Ridenour, Newman, and DeMarco (2003: 143) notes that MMR often results in a range of options, rather than a set of dichotomies. MMR is characterised by the replacement of the “either–or” with a continuum.

Creswell (2009:102) argues that the incompatibility argument, which states that one cannot mix paradigms and that research teams cannot be comprised of specialists in qualitative and quantitative research, is incorrect. Creswell (2009:103) mentions the emergence of a *Community of Scholars* idea, which presents four versions of the concept of paradigms. Paradigms are “shared belief systems” which “influence the kinds of knowledge researchers seek and how they interpret the evidence they collect” (Morgan, 2007:50). Paradigms can be viewed as worldviews, or shared beliefs held by individual communities of practice (such as certain speciality areas or research fields) regarding the best or standard solutions to problems. In this manner, researchers in a specific field often share a set of beliefs regarding the most appropriate procedures to answer questions in that field (Morgan, 2007:53). This has led to various disciplines adopting MMR in different ways and creating unique practices.

4.6.4 Main components of the mixed–method design

Creswell and Clark (2007: 72) mention four types of MMR design. These are:

- Triangulation (concurrent) – One phase of data collection, where data is gathered concurrently;
- Explanatory designs – Two phases of data collection – Quantitative followed by qualitative research;
- Exploratory designs – Two phases of data collection – Qualitative followed by quantitative research; and
- Embedded designs – One form of design is embedded in another.

Another type of MMR design mentioned by Creswell (2009:104) is complex design, where there are multiple stages. It combines both sequential and concurrent phases. In these types of designs, unusual methods are blended, resulting in the combination of quantitative and qualitative longitudinal data, and secondary data with qualitative follow–ups, for example.

4.7 Designing, constructing, and executing the mixed–method study

An MMR design was used in the creation of the previous PDRIs. This study was also based on an MMR design. Halcomb and Hickman (2015:49) note that one way in which an MMR research design can be used is in Instrument Development. This is done by using a qualitative study to develop a quantitative instrument. In the previous PDRIs, qualitative methods (interviews and focus groups) were used to establish the list of elements applicable to the industry. After that, quantitative methods (surveys followed by statistical analysis) were used to assign weights to the check sheet, and validate the instrument. This study followed a similar approach.

Onwuegbuzie and Collins (2007:282) note that random sampling is often associated with quantitative research, and non–random sampling with qualitative research. Either type of sampling can be used with either type of research, however. Onwuegbuzie and Collins (2007:282) mention that the size of samples is also associated with certain types of research. Small samples are often associated with qualitative research while quantitative studies are generally associated with larger samples. However, Onwuegbuzie and Collins (2007) note that this can also be misleading. The objective of the study will often dictate the sampling scheme to be used in an MMR design. Many MMR designs incorporate some form of purposeful sampling, where a specific individual or group is targeted, to investigate and understand a specific event or phenomenon.

Onwuegbuzie and Collins (2007:287) state that there are 24 sampling schemes which mixed–method researchers can choose from. These are depicted in Table 4.3.

Table 4. 3 – Sampling schemes in mixed–method research

Sampling Scheme	Description
Simple	Every individual in the sampling frame has an equal and independent chance of being chosen for the study
Stratified	The sampling frame is divided into sub–sections comprising groups that are relatively homogeneous with respect to one or more characteristics and a random sample from each stratum is selected
Cluster	Selecting intact groups representing clusters of individuals rather than choosing individuals one at a time
Systematic	Choosing individuals from a list by selecting every nth sampling frame member, where n typifies the population divided by the preferred sampling size
Multi–Stage Random	Choosing a sample from the random schemes in multiple stages
Maximum Variation	Choosing settings, groups, and/or individuals to maximize the range of perspectives investigated in the study
Homogenous	Choosing settings, groups, and/or individuals based on similar or specific characteristics
Critical Case	Choosing settings, groups, and/or individuals based on a specific characteristic(s) because their inclusion provides the researcher with compelling insight into the phenomenon of interest
Theory–Based	Choosing settings, groups, and/or individuals because their inclusion helps the researcher develop a theory
Confirming Disconfirming	After beginning data collection, the researcher conducts subsequent analyses to verify or contradict initial results
Snowball/Chain	Participants are asked to recruit individuals to join the study
Extreme Case	Selecting outlying cases and conducting comparative analyses
Typical Case	Selecting and analysing average or normal cases
Intensity	Choosing settings, groups, and/or individuals because their experiences relative to the phenomena of interest are viewed as intense but not extreme
Politically important Case	Choosing settings, groups, and/or individuals to be included or excluded based on their political connections to the phenomena of interest
Random Purposeful	Selecting random cases from the sampling frame and randomly choosing a desired number of individuals to participate in the study
Stratified Purposeful	The sampling frame is divided into strata to obtain relatively homogenous sub–groups and a purposeful sample is selected from each stratum
Criterion	Choosing settings, groups, and/or individuals because they represent one or more criteria
Opportunistic	Researcher select a case based on specific characteristics (i.e. typical, negative, or extreme) to capitalize on developing events occurring during data collection
Mixed Purposeful	Choosing more than one sampling strategy and comparing the results emerging from both samples

Sampling Scheme	Description
Convenience	Choosing settings, groups, and/or individuals that are conveniently available and willing to participate in the study
Quota	Researcher identifies desired characteristics and quota of sample members to be included in the study
Multi–stage Purposeful Random	Choosing settings, groups, and/or individuals representing a sample in two or more stages. The first stage is a random selection and the following stages are a purposive selection of participants
Multi–stage Purposeful	Choosing settings, groups, and/or individuals representing a sample in two or more stages in which all stages reflect a purposive sampling of participants

Source: Onwuegbuzie and Collins (2007:287)

Of the mentioned schemes,19 are purposeful (non–random), while the remaining five are random. Non–random sampling is often used in mixed–method research, where participants are chosen because they are "information–rich" (Patton, 1990:169). According to Onwuegbuzie and Collins (2007:287), non–random sampling is used when the goal of the research is not to generalise findings to a population but to obtain insights into specific areas. Teddlie and Yu (2007: 78) put forth four broad sampling categories, spread over 15 sampling procedures, which are usually used in social and behavioural sciences. These procedures are:

- Probability Sampling;
- Random Sampling;
- Stratified Sampling;
- Cluster Sampling;
- Sampling using multiple probability techniques;
- Purposive Sampling;
- Sampling to achieve representativeness or comparability;
- Sampling special or unique cases;
- Sequential sampling;
- Sampling using multiple purposive techniques;
- Convenience sampling;
- Captive sampling;
- Volunteer sampling;
- Mixed–methods sampling;

- Basic mixed–methods sampling;
- Sequential mixed–methods sampling;
- Concurrent mixed–methods sampling;
- Multilevel mixed–methods sampling; and
- Combination of mixed–methods sampling strategies.

Onwuegbuzie and Collins (2007:288) argue that the sample size is as important as the sampling scheme, as it determines the level of generalisation which the researcher can make. Proposed minimum sample sizes for various research designs are depicted in Table 4.4.

Table 4. 4 – Proposed minimum sample sizes for various research designs.

Research Design/Method	**Minimum Sample Size Suggestion**
Correlational	64 participants for one–tailed hypotheses; 82 participants for two–tailed hypotheses (Onwuegbuzie et al., 2004)
Causal–Comparative	51 participants per group for one–tailed hypotheses; 64 participants for two–tailed hypotheses (Onwuegbuzie et al., 2004)
Experimental	21 participants per group for one–tailed hypotheses (Onwuegbuzie et al., 2004)
Case Study	3–5 participants (Creswell, 2002)
Phenomenological	<= 10 interviews (Creswell, 1998); >= 6 (Morse, 1994)
Grounded Theory	15–20 interviews (Creswell, 2002); 20–30 (Creswell,2007)
Ethnography	1 cultural group (Creswell, 2002); 30–50 interviews (Morse, 1994)
Ethological	100–200 units of observation (Morse, 1994)
Sampling Design Subgroup Sampling Design Nested Sampling Design	>= 3 participants per subgroup (Onwuegbuzie & Leech, 2007c) >= 3 participants per subgroup (Onuegbuzie & Leech, 2007c)
Data Collection Procedure Interview Focus Group	12 participants (Guest, Bunce & Johnson, 2006) 6–9 participants (Hrueger, 2000); 6–10 participants (Langford, Schienfeld & Izzo, 2002; Morgan, 1997); 6–12 participants (Johnson & Christensen, 2004); 6–12 participants (Bernard, 1995); 8–12 participants (Baumgartner, Strong & Hensley, 2002) 3 to 6 focus groups (Krueger, 1994; Morgan, 1997); Onwuegbuzie, Dickson, Leech & Zoran, 2007)

Source: Onwuegbuzie and Collins (2007:288)

Teddlie and Yu (2007:87) add that researchers must often make sampling decisions based on available resources, such as time and money. The decision, when faced with these constraints, on where to compromise, is called the representativeness/saturation trade–off. According to Teddlie and Yu (2007:88), the more emphasis is placed on the quantitative study, the less is placed on the qualitative study, and vice versa. In qualitative research, it is essential to note when saturation is achieved. According to Krueger and Casey (2000:26), this happens when the point is reached where the same ideas keep re–appearing, and no new information is received. In quantitative research, the sample size can be affected by available resources, the size of the population, and the sampling technique used. Teddlie and Yu (2007:84) hold that if purposive sampling is used, sample sizes are typically smaller (less than 30), while sample sizes in probability sampling are typically large enough to establish representativeness (usually larger than 50 units). This is because a purposive sample typically picks a small number of cases that will yield the most information regarding a phenomenon, while a probability sample is planned to target a large sample which represents the population.

Curtis, Gesler, Smith and Washburn (2000:1011) propose that efficient sampling designs are essential for ensuring that the study can be undertaken using available resources, such as money and time. The sampling design should consider the competencies and experience of the researcher. The potential sample members should also be considered, so as not to inconvenience those involved in the sampling unduly.

Although there are researchers who believe that quantitative and qualitative methods should not be mixed and that some research methods are superior to others, numerous studies and literature favour a mixed–method research design approach. MMR has been shown to be favoured in certain schools of practice, as well as for investigating a specific phenomenon. Exploratory designs, aimed at developing an instrument, seem particularly suited to an MMR approach, as it uses qualitative data, followed by quantitative data, to develop a tool or instrument, and the RAT is such a tool. That is why the MMR approach was utilised in conducting this research.

4.8 The methodology followed in previous PDRIs

The methodology followed in the previous four PDRI studies, had several shared elements (Gibson and Dumont, 1996:21; Cho et al., 1999: 35; Bingham, 2010:28; Collins, 2015:78). The similarities and differences in the method of developing the list of elements, as well as the weighting and validation are illustrated in Table 4.5.

Table 4. 5 – Comparison of methodology in compiling the previous PDRIs

Method followed	Industrial projects	Building projects	Infrastructure projects	Small industrial projects
Compiling the list of elements	X			
Literature review	X			
Documentation from owner and contractor organisations	X		X	
Expertise of research team	X			X
Workshop with project Managers and estimators	X			
Previous PDRI		X	X	X
Focus group		X		
Discussion with experts (number)		X		
Breakdown of PDRI				
Number of elements	69	64	68	41
Number of categories		11	13	8
Number of sections		3	3	3
Weighting the elements				
Participants	54	69	64	65
Validating the PDRI				
Number of projects	23	33	22	40
Determining project success				
Budget/Cost Performance	X	X	X	X
Schedule Performance	X	X	X	X
%Design capacity achieved after 6 months	X			
Plant Utilization attained after 6 months	X			
Overall project success rating	X			
Number of design changes		X		
Change Cost Performance		X	X	X
Actual vs expected performance of project				
Operational performance				
Customer satisfaction score				

A summary of the methodology followed during the compilation of each of the previous PDRIs is given in the next sections.

4.8.1 PDRI for industrial projects

Finalising the list of elements

The team responsible for the PDRI for industrial projects used four methods to compile the list of elements in the PDRI (See Table 4.5). These were:

- A literature review;
- Documentation from various owner and contractor organisations;
- The expertise of the research team; and
- A workshop with project managers and estimators (Gibson and Dumont, 1996:21).

During this process, the initial list of 150 elements was trimmed to an eventual 69 elements.

Workshop to weight the elements

After the list of elements and descriptions were updated, two workshops were held to weight the elements. The weighting methodology was explained and discussed in the two workshops, in which 54 individuals from 31 owner and contractor companies participated. Participants weighed the elements based on the relative importance of the various elements.

Analysing the data

Each data form was normalised to a 1000–point scale before the final element scores were calculated. After calculating the final scores, a statistical analysis was carried out to determine the level of variance within the various elements. The mean, median, variance, standard deviation, skewness, and kurtosis were calculated. Where the statistical analysis of one or more of the individual elements indicated that the data contained values which skewed their distribution to the positive extreme, the data was discarded, and the final element weights were calculated.

Validating the PDRI

Once the PDRI was weighted, it needed to be validated. The intention was to correlate the PDRI score with project success ratings of actual projects. To collect the data, questionnaires were sent to the participants in completed projects. The questionnaires contained background information questions regarding the projects (such as Cost Performance, Schedule Performance, and the number of change orders of the project), as well as a PDRI score sheet. The participants were asked to evaluate the project's Scope Definition package for completeness at the time that it was authorised to proceed to detail design and implementation.

When the completed feedback forms were received back, the research team calculated PDRI scores for all the projects. The feedback was compared to the relative success of the project. To determine the relative success of the project, the research team expanded on previous research to determine a project success rating (Gibson and Dumont, 1996:54). This rating was based on four variables, namely:

- Budget Achievement – Whether the project came in under, on or over budget;
- Schedule Achievement – Whether the project came in under, on or over budget;
- Percentage design capacity achieved after six months – Over 100% of planned achieved, 100% achieved, under 100% achieved; and
- Plant Utilization attained after six months – Over 100% of planned, 100% of planned, less than 100% of planned.

The Project Success Ratings, as well as the PDRI scores, were calculated for the 23 participating projects. A scatter plot was done comparing Project Success Ratings vs PDRI scores, and a regression analysis was performed to confirm the correlation between a low PDRI score and a high Project Success Rating. It was determined that projects with a PDRI score below 200 consistently outperform those with a PDRI score above 200. It was also determined that a lower PDRI score resulted in a better cost and Schedule Performance.

4.8.2 PDRI for Building Projects

Finalising the list of elements

Following the completion of the PDRI for Industrial Projects, the need was identified to compile a PDRI for building projects. The research team responsible for the PDRI for Building Projects made use of a draft PDRI for Building Projects which had been compiled earlier as a continuation of the PDRI for Industrial Projects. This draft had gone through five iterations and had been discussed with 13 industry participants as well as in a focus group (Cho et al., 1999: 19).

Workshop to weigh the elements

As part of the weighting process, participants were asked to consider a recent project in their respective organisations, in which they were involved. The participants were instructed to assume that they were at the end of the front–end planning phase, and about to start with detail design and implementation. Participants had to assign a percentage of contingency for a level 1 Scope Definition (Complete definition) as well as a level 5 Scope Definition (Incomplete or poor definition) for each element (Gibson and Dumont, 1996:38).

Analysing the data

After the workshops were completed, the data was normalised. This was necessary, as different participants used different scales. By normalising the data to a 1000–point scale, the weighting forms could be compared and used in the final weight calculation.

After all the weighting forms were normalised, the preliminary weights for all the scope elements were calculated. The descriptive statistics (mean divided by median, standard deviation, and skewness) indicated that for some elements, the mean was obtained from a skewed distribution with high variances. It was therefore decided to eliminate specific datasets which frequently skewed the distribution. A boxplot was used to screen the data. Extremes and outliers were identified using this method. A total of eight datasets were eliminated in this manner. The remaining 59 datasets were then used to calculate the final weights for the PDRI elements.

Validating the PDRI

To validate the instrument, it was tested on completed projects. The goal was to correlate PDRI scores to project success criteria such as Cost Performance, Schedule Performance, change orders and customer satisfaction. Validation questionnaires were mailed to participants from completed projects. The questionnaires measured the level of definition of PDRI elements before proceeding into detail design and construction, as well as the relative success of the projects.

A PDRI score which distinguishes between successful and unsuccessful projects was calculated as 200 points. This was done by testing the mean performance of projects using several PDRI sample segregation points (such as 150, 200 and 210).

The mean value of project performance variables was compared at a 95 per cent confidence interval, using these segregation points.

4.8.3 PDRI for Infrastructure Projects

Finalising the list of elements

The research team drafted the initial list of elements, using the PDRIs for Building and Industrial Projects, (Bingham, 2010) as well as elements from the Advanced Planning Risk Analysis (APRA) tool developed by the Texas Department of Transport (TxDOT) (Caldas et al., 2007). The research team revised the initial list by modifying terms to be more in line with those used in the infrastructure construction community. Some elements which are unique to the infrastructure industry were added, while others which were not applicable, were removed. In this manner, a list of 68 elements was drawn up, which served as the draft PDRI worksheet, which would be used in the weighting workshops.

Workshop to weight the elements

Six workshops were conducted to assign weights to the various elements of the PDRI for Infrastructure Projects. In total 64 participants took part in the weighting and testing of the tool. Participants were asked to consider a typical project in their organisation. They were asked to assign contingency amounts to each element, assuming alternatively that the scope of that element had been defined completely, or if the scope had little or no definition.

Analysing the data

After the weighting workshops were completed, the research team developed a weighted score sheet. The individual elements were scrutinised for skewness by calculating their respective means, medians, standard deviations, variances, and skewness. To ensure that the data used was close to normally distributed, boxplots were created to analyse the outliers and extremes. The goal was to determine if there were specific data sets or participants whose inputs were continuously skewing the data. The team calculated a contribution score for each participant and used this score to eliminate the entire contribution of specific individuals whose inputs were deemed to be skewing the datasets excessively.

Validating the PDRI

The PDRI for Infrastructure Projects was tested on completed projects, as well as ongoing projects. Both successful and unsuccessful projects were used in the validation.

A questionnaire was mailed to 14 volunteering organisations, along with an unweighted PDRI scorecard and element descriptions. There were 22 projects involved in this step, representing over $ 6 billion. Success was measured using overruns in cost, schedule and the amount of capital required for change orders.

The research team analysed different PDRI scores, such as 150, 200 and 250 points, to use as cut–off points between successful and unsuccessful projects. The final cut–off level was determined as 200 points, in line with the previous PDRIs.

The Schedule Performance for projects with a PDRI score below 200 was found to be significantly better than for those projects with a PDRI score above 200. The Cost Performance of projects having a PDRI score lower than 200 were also significantly better than the rest. Change Performance was also analysed by determining the ratio of the cost of changes during project implementation to the actual project cost. Projects with a PDRI score below 200 had an average Cost Performance of only 3.1 per cent of the total cost, while those with a PDRI score above 200 averaged 10 per cent of the project cost.

4.8.4 PDRI for Small Industrial Projects

Finalising the list of elements

The research team responsible for the PDRI for Small Industrial Projects followed a similar approach to that of the previous three PDRI research teams. The PDRI for Infrastructure Projects formed the basis from which the element descriptions were developed. Some elements were removed, some were combined with other elements, and some new elements were included. This list was used in the weighting workshops.

Workshop to weigh the elements

There were 65 participants representing 29 organisations in the workshops, representing owners and contractors. Participants were asked to consider a typical project in their organisations while completing the weighting form. Participants were asked to provide contingency amounts (as a percentage impact of the individual element on total installed cost, based on the original estimate just before proceeding with detail design).

Analysing the data

The research team normalised the data received during the workshops. Data was normalised similarly to the previous PDRIs, where the sum of all Level 1 definitions equalled 70, while the sum of all Level 5 definitions equalled 1000. The research team wanted to use data sets that were close to normally distributed only to create the weighted score sheet. Therefore, skewed data sets were identified by calculating descriptive statistics (mean, median, standard deviation, variance, and skewness) after the data was normalised. Several elements were found to be either moderately or highly skewed, which indicated that some of the data sets were skewing the overall data set. Boxplots were used to identify participant weights that were skewing the mean element weights.

Like for previous PDRIs, it was decided to remove the inputs from individual participants, based on the contribution scores which indicated that their inputs were causing skewness. Element weights were calculated after the contributions which were skewing the data, were removed.

Validating the PDRI

Participants in the workshops, as well as research team members, were asked to consider recent projects, both successful and unsuccessful, while completing a questionnaire. Volunteers were asked to provide the relevant information regarding a recent project in their organisation and complete the unweighted PDRI score sheet based on the level of Scope Definition that had been achieved just before proceeding with detail design and construction.

The PDRI scores calculated from the returned forms, ranged from 93 to 774, with an average score of 290. Schedule Performance, Cost Performance and Change Performance Scores were calculated for all projects, and this was correlated with the PDRI scores achieved by the project. Independent sample t–tests, boxplots, and regression analysis were then used to determine a PDRI score which represented a statistically significant difference between successful and unsuccessful projects.

Projects with PDRI scores above 300 were determined to underperform against projects with PDRI score of less than 300 with regards to cost, schedule and change orders. Customer satisfaction was also found to be higher for projects with a PDRI score lower than 300.

4.8.5 Conclusions on structure of PDRIs

The processes followed during the creation of the CII's PDRIs provides a proven structure, which forms the basis for this study. For purpose of this study, a similar structure was considered for development of a Readiness Assessment Tool for Mining Projects. The process followed in this study to compile a weighted Readiness Assessment Tool for Mining Projects, is indicated diagrammatically in Figure 4.2.

This process is further explained in the following section.

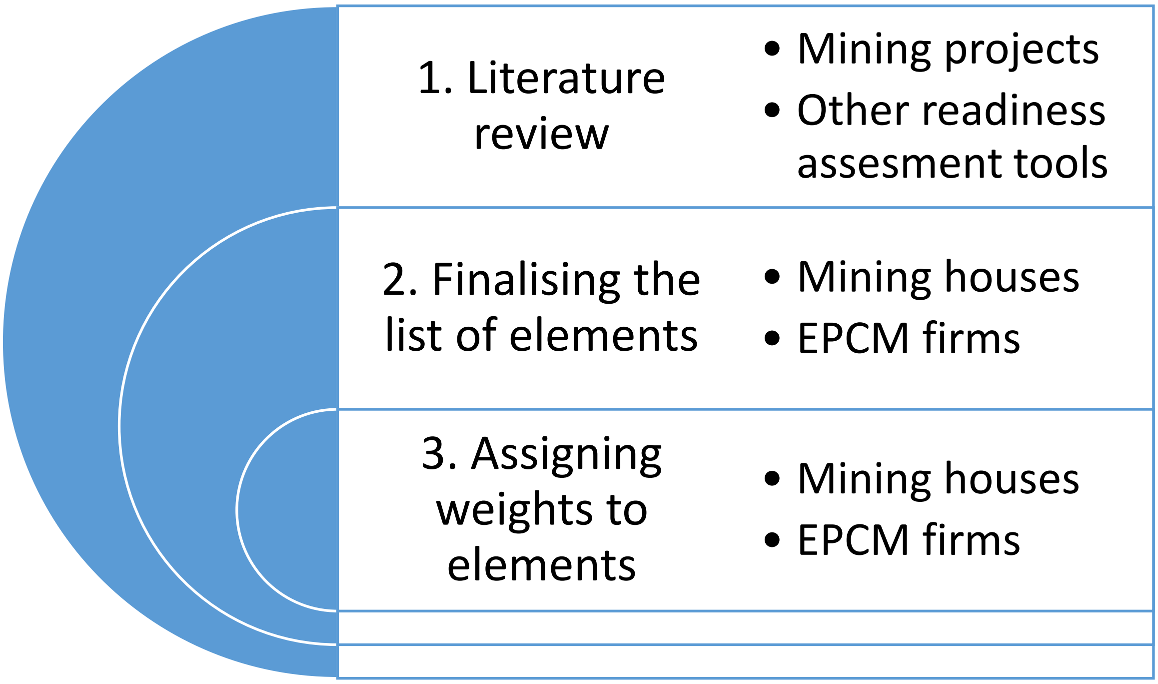


Figure 4.2 Process to compile a weighted Readiness Assessment Tool for Mining Projects

4.9 The methodology followed during this study

The research methodology followed in establishing a RAT for mine projects, is based on a combination of the methodologies employed in the previous PDRI studies (as discussed in Section 4.7). This methodology is discussed in detail in Section 4.8.

4.9.1 Finalising the list of elements

The various Elements, Categories and Sections of the RAT had to be established to arrive at an unweighted RAT check sheet. In developing the previous four PDRI tools, this method included a combination of literature reviews (which included the previous PDRI tools), focus group discussions, workshops, scrutiny of project documentation and one–on–one discussions with experts (Gibson and Dumont, 1996:21; Cho et al., 1999: 35; Bingham, 2010:28; Collins, 2015:78).

The study to compile a RAT for Mining Projects followed the same approach as the previous four PDRIs. This included examining the existing literature, both on previous PDRIs and on projects in the mining industry in general. The aim was to define elements which apply to projects in the mining industry. Where required, the existing elements which were used in previous PDRIs were modified to suit the mining industry.

Data was gathered using a mixed–method approach to compile a draft (unweighted) RAT. The primary method of compiling the unweighted RAT was to gather inputs from experts in mining houses via telephonic interviews as well as emails. These inputs were compiled into a draft unweighted RAT. It was then tested with several Engineering / Procurement / Construction and Management consultants (EPCMs) who are involved with planning and executing mining projects. A list of definitions for all the elements was compiled, to ensure a uniform understanding of the meaning of each element.

The unweighted RAT for Mining Projects was distributed via email to 66 mining project professionals, both in mining and EPCM companies. The participants were asked to weight and assess the various elements which pertain to the front–end planning phase of mining projects. These role players were situated mainly in North America, Africa, and Australia. The outcome of this exercise was a weighted RAT for Mining Projects.

A questionnaire was developed to test the RAT for Mining Projects, based on completed projects. In the questionnaire, participants were asked to consider completed projects and to indicate the level of Scope Definition for the various elements at the time of approval. Participants were also asked to supply information regarding the completed projects, which could be used to determine the relative success of the projects.

Analytical reviews of the data received via questionnaires were conducted to validate the RAT research hypotheses. This included:

- Standard deviation measurements;
- Comparison of means;
- Regression analysis;
- Box plots; and
- Independent sample *t*–test analysis.

Outliers were removed, and data weights set to reanalyse data. The outcome of this final analysis was used to finalise the RAT for Mining Projects tool, as well as to validate the RAT research propositions. The process is described diagrammatically in Figure 4.3, adapted from Bingham (2010:38).

Each of the previous PDRI development teams followed a slightly different approach in finalising the list of elements (Gibson and Dumont, 1996:21; Cho et al., 1999: 35; Bingham, 2010:28; Collins, 2015:78). However, all the previous teams followed a process which ensured that:

- Various experts scrutinised the list of elements which ended up in the eventual PDRI; and
- the terminology used was appropriate to the industry where the PDRI was to be applied.

In compiling the RAT for Mining Projects, it was important that experts evaluated the list of elements, and that the terminology was appropriate to the industry.

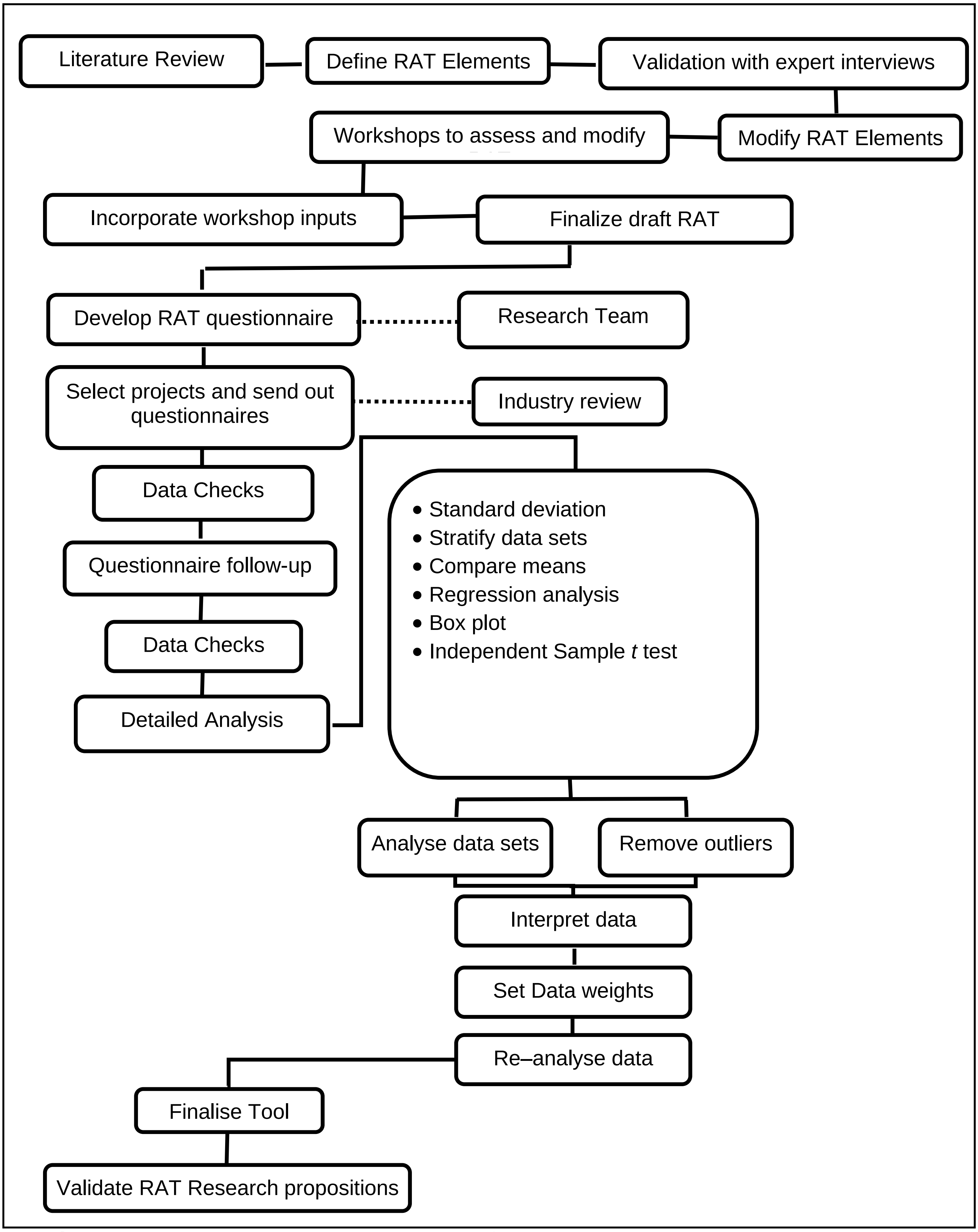


Figure 4. 3 – RAT Development process flow

The process followed in establishing the final list of elements for the RAT for Mining Projects is indicated in Table 4.6. The Annexures in which the various components of this process are shown is also depicted in Table 4.6.

Table 4. 6 – Process to establish a final list of RAT Elements

Activity	Comments	Notes	Annexure
1	Preliminary check sheet compiled	Combination of literature review and previous PDRIs	A
2	Email sent to participants to requests inputs	Participants represent mining houses	
3	Inputs from Participant 1 received via telephone	Telephonic focus group	
4	Inputs received from Participant 2	2 x Email and 2 x spreadsheet	B
5	Inputs received from Participant 3	Email and spreadsheet	B
6	Preliminary check sheet updated with inputs from mining houses		C
7	Email sent to participants to requests inputs	Participants represent EPCMs	
8	Inputs received from Participant 4	Emails	D
9	Inputs received from Participant 5	Emails & Spreadsheet	D
10	Inputs received from Participant 6	Email & Spreadsheet	D
11	Inputs received from Participant 7	Email & Spreadsheet	D
12	Check sheet finalised with inputs from EPCMs		

The first step in compiling a final list of RAT elements for Mining Projects check sheet was to scrutinise the elements used in the four existing RATs, to decide which of these would apply to the RAT for Mining Projects. This was done based on the experience of the researcher. Elements which were not applicable to mining projects were not included, but where there was any doubt the elements were included in the draft list, as these could be removed later. The draft list of elements was further increased by adding elements which were identified during the literature review. The draft list, along with the sources (such as literature review and previous PDRIs) can be seen in Annexure A. During the literature review, it became apparent that, due to the complexity of mining projects and the depth of study work required, the number of elements to be considered would be significantly more than the previous PDRIs.

The draft list which was compiled during the scrutiny of previous PDRIs and the literature review formed the basis for engagements with industry experts. These engagements were aimed at evaluating the list of elements and arriving at a definitive list of elements to be considered during a project study. The list of draft RAT Elements, Categories and Sections, which was used as a basis for requesting inputs from mining houses, is shown in Annexure A, along with the source of the various elements. The sources of the various elements are either the previous four PDRIs or specific references in literature.

When considering the long study and implementation timelines of typical mining projects, it became clear that the level of experience required to be able to complete the surveys would be significant. Typical mining projects have long study and implementation durations, which limit the pool of potential participants in the study to older, more experienced project professionals. A typical mining project study takes up to 16 years to complete. The construction (development) takes on average one to three years (KPMG International 2012:2).

The assistance of five mining houses was sought to give inputs on the applicability of the Elements, Categories and Sections which made up the draft RAT check sheet. Representatives of one of the mining houses participated via a focus group discussion, while two other mining houses participated via email. The contents of the responding email messages, as well as the comments which were made on the spreadsheets which were attached to the messages, are shown in Annexure B. The inputs consisted primarily of individual elements being added to the original list, based on the experience of the participants.

The inputs from the various mining houses were incorporated and the draft RAT check sheet updated to reflect the proposed changes. This process entailed adding, removing, and combining some of the elements, as well as a regrouping of some the Categories and Sections, as suggested by the participants. The draft RAT check sheet after this update is shown in Annexure C.

After the draft, RAT check sheet was updated with the comments of the mining houses. Five Engineering, Procurement, Construction and Management (EPCM) companies were asked to comment on the preliminary RAT for Mining Projects list. An email was sent to the participating EPCMs, requesting them to evaluate the draft RAT list as it was at that stage, and to provide comments. Four of the EPCM companies responded to this request. The responses via email and the comments on the RAT check sheets are attached in Annexure D. By incorporating the comments from these experts, the list of elements was finalised. This process involved adding and removing certain elements, based on the comments of the EPCMs. The inputs form the EPCMs were also used to finalise the Categories and Sections into which the elements were sub–divided. During these interactions, the applicability of the wording was also checked. Where required, the wording was adapted or modified to be more in line with mining project terminology. The process followed to determine the final unweighted RAT sheet is depicted in Figure 4.4.

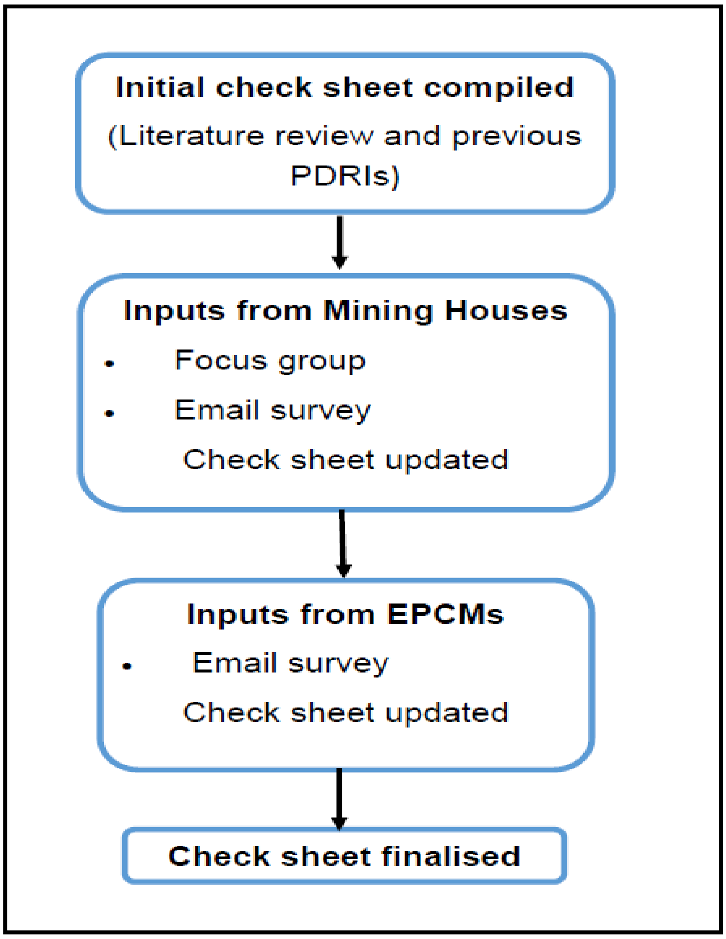


Figure 4. 4 – The process to establish the final list of RAT Elements

The final unweighted RAT check sheet is depicted in Annexure E. It consisted of 180 elements, which were divided into four Sections and 18 Categories. This check sheet was used as the basis of the survey for assigning weights to the various elements. A literature review was conducted to assign definitions to the various elements. Whenever the element was present in any of the previous PDRIs, the definition from the previous PDRI was used. For new elements, the definition came from literature. This is presented in Chapter 2. The definitions would be useful in assisting participants in the survey, but also when the tools were completed, as project professionals could use the definitions to avoid any misunderstandings regarding terminology when using the tool. The four sections which the RAT is divided into, are:

- Basis of Project Decision,
- Project Details,
- Design for Construction, and
- Implementation Approach.

The four sections are further divided into numerous categories. The Basis for Project Decision section is made up of seven categories. The Projects Details section is divided into three categories. The Design for Construction section is divided into three categories, and the Implementation Approach section into five categories. The list of Sections, Categories and Elements are depicted in Table 4.7. Each element has a definition. The list containing the Sections, Categories, Elements and Definitions are given in Annexure E.

The elements of the RAT do not all carry the same weight. This means that certain elements, if given adequate attention during the study, contribute more towards the success of a project. After completing the list of RAT elements, categories and sections, the next step was to gather information, to assign weights to the various elements.

Table 4. 7 – List of RAT Sections, Categories and elements with new elements highlighted

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		**COMMENTS**
A	**PROJECT STRATEGY**	
A.1	Project Justification	Existing Element
A.2	Project Charter and Mandate	New Element
A.3	Governance and control (internal approval process defined)	New Element
A.5	Project Strategy	Existing Element
A.6	Strategic fit of project in organisation	New Element
A.7	Due diligence	
A.8	Partnership, joint ventures, and shareholder buy–in	New Element
B	**COUNTRY RISK**	
B.1	Social Issues	New Element
B.2	Geopolitical risks	New Element
B.3	Fiscal stability agreement	New Element
B.4	Social License to Operate	New Element
B.5	Violence and terrorism	New Element
B.6	Ability to appoint expatriates	New Element
B.7	Procurement of local and foreign materials, services, and equipment	New Element
B.8	Country infrastructure (power, roads, rail, water ports)	New Element
B.9	Custom duties & logistic routes	New Element
C	**PROJECT FEASIBILITY**	
C.1	Resources secured (including land and mineral rights)	New Element
C.2	Financing secured (Internal, external, equity, debt)	New Element
C.3	Business Plan	Existing Element
C.4	Economic Analysis	Existing Element
C.5	Affordability / Feasibility	Existing Element
C.6	Contingencies (Capex & Opex)	Existing Element (Capex & Opex added)
C.7	Basis of Estimate	New Element
C.8	Scenario planning	New Element
D	**RESOURCE AND RESERVE STATEMENT**	New Element
D.1	Metallurgical yield	New Element
D.2	Reserve risks (including modifying factors)	New Element
D.3	Grade engineering / control	New Element
D.4	Prospect drilling standard / guideline	New Element
D.5	Geological conditions (Geological model, structure, qualities)	New Element

E	**LIFE OF MINE PLANNING**	
E.1	Mine design criteria	New Element
E.2	Shaft/ramp design & men and material logistics	New Element
E.3	Mining methods (drilling, blasting, loading, hauling)	New Element
E.4	Equipment selection to fit geological conditions and mining method	New Element
E.5	Life–of–mine plan	New Element
E.6	Waste management plan	New Element
E.7	Ultimate pit limits designed	New Element
E.8	Economic block values determination	New Element
E.9	Beneficiation facilities LOM plan	New Element
E.10	Materials handling LOM plan	New Element
F	**OPERATING PHILOSOPHY**	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	Existing Element (Outsourcing vs Internal vs Combination added)
F.2	Productivity / efficiency benchmarks	New Element
F.3	Operating costs	New Element
F.4	Production risks	New Element
F.5	Catalogue of operating plans	New Element
F.6	Haul roads	New Element
F.7	Transportation strategy	New Element
F.8	Contractual considerations	New Element
G	**MARKET ANALYSIS AND STRATEGY**	
G.1	Market Strategy & Sales Agreements	New Element
G.2	Price risks	New Element
G.3	Demand risks & replacement products / technologies	New Element
G.4	Value–Analysis Process	New Element
G.5	Hedging	New Element
G.6	Competitor analysis	New Element
SECTION II – PROJECT DETAILS		**COMMENTS**
H	**PROJECT CONSIDERATIONS**	
H.1	Expected Project Life Cycle	Existing Element
H.2	Assumption register	New Element
H.3	Completion risks	New Element
H.4	Project Design Criteria	Existing Element
H.5	Scope of Work Overview	Existing Element
H.6	Project Schedule	Existing Element
H.7	Project Cost Estimate	Existing Element
H.8	Investment Studies & Alternatives Assessments	Existing Element
H.9	Key Team Member Coordination	Existing Element

H.10	Evaluation of Compliance Requirements	Existing Element
H.11	Lead / Discipline Scope of Work	Existing Element
H.12	Housing and transport of employees	New Element
H.13	Risk or impact on other projects / divisions	New Element
I	**PROJECT SCOPE**	
I.1	Project Objectives Statement	Existing Element
I.2	Site Characteristics Available vs. Required	Existing Element
I.3	Project Scope Definition	Existing Element
I.4	WBS and WBS Dictionary	New Element
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	
J.1	Unique mine closure plan	New Element
J.2	Land use plan post operations	New Element
J.3	Social expectations register	New Element
J.4	Relocation Action Plan	New Element
J.5	Environmental expectations register	New Element
J.6	Political expectations register	New Element
J.7	Legal compliance register	New Element
J.8	HSE risk register	New Element
J.9	Community risk register	New Element
J.10	Business risk register	New Element
J.11	Developmental opportunity register	New Element
J.12	Sustainability operating plan	New Element
J.13	Stakeholder engagement plan	New Element
J.14	Mine closure financial provision plan	New Element
J.15	Closure plan review and updates scheduled during Life of Mine plan	New Element
J.16	Social investment plan	New Element
J.17	Economic diversification plan	New Element
J.18	Existing Environmental Conditions	Existing Element
J.19	Environmental Process determined	New Element
J.20	Environmental management plan	New Element
K	**SITE INFORMATION**	
K.1	Site Layout	Existing Element
K.2	Site Surveys	Existing Element
K.3	Governing Regulatory Requirements	Existing Element
K.4	Utility Sources with Supply Conditions	Existing Element
K.5	Fire Protection, emergency procedure & Safety Considerations	Existing Element (emergency procedures added)
K.6	Special Water and Waste Treatment Requirements	Existing Element
K.7	Property Descriptions	Existing Element
K.8	Right–of–Way Mapping & Site Issues	Existing Element
K.9	Land Rights	New Element

L	PROJECT DESIGN PARAMETERS	
L.1	Design Criteria	Existing Element
L.2	Civil/Site Design	Existing Element
L.3	Geotechnical investigation for structures	
L.4	Architectural Design	Existing Element
L.5	Structural Design	Existing Element
L.6	Mechanical Design	Existing Element
L.7	Electrical Design	Existing Element
L.8	Constructability Analysis	Existing Element
L.9	Process Design	New Element
L.10	Specifications	Existing Element
L.11	Speciality Items List	Existing Element
L.12	Instrument Index	Existing Element
L.13	Control Philosophy & systems	Existing Element
L.14	Logic Diagrams	Existing Element
L.15	IM (information management)	New Element
L.16	Control of Access	Existing Element
L.17	Safety & Hazards	Existing Element
L.18	Operations/Maintenance	Existing Element
L.19	Ventilation Engineering	New Element
L.20	Rock Engineering	New Element
L.21	Water balances	New Element
L.22	Energy efficiency / carbon footprint	New Element
L.23	Tailings handling and storage	New Element
L.24	Stormwater handling / surface hydrology	New Element
L.25	Internal technical audits	New Element
L.26	External technical audits	New Element

M	VALUE IMPROVING PRACTICES	
M.1	Process Simplification	Existing Element
M.2	Design & Material Alternatives Considered/Rejected	Existing Element
M.3	Technology trends	New Element
M.4	Design to capacity	New Element
M.5	Classes of facility quality	New Element
M.6	Energy optimisation	New Element
M.7	Waste minimisation	New Element
M.8	3D / 4D design	New Element
M.9	Cleaner Production	New Element
M.10	Innovation and knowledge management planning	New Element
M.11	Six Sigma	New Element
M.12	Lean Manufacturing	New Element

SECTION IV – IMPLEMENTATION APPROACH		COMMENTS
N	**PROCUREMENT STRATEGY**	
N.1	Identify Long Lead/Critical Equipment and Materials	Existing Element
N.2	Procurement Procedures and Plans	Existing Element
N.3	Procurement Responsibility Matrix	Existing Element
N.4	Draft contracts & proforma bidders pack	New Element
N.5	Contracting strategy	New Element
N.6	Procurement operation plan (POP)	New Element
O	**DELIVERABLES**	
O.1	CADD/Model Requirements	Existing Element
O.2	Deliverables Defined	Existing Element
O.3	Distribution Matrix	Existing Element
O.4	Documentation/Deliverables	Existing Element
P	**PROJECT CONTROLS**	
P.1	Project Quality Assurance and Control	Existing Element
P.2	Project Cost Control	Existing Element
P.3	Project Schedule Control	Existing Element
P.4	Risk Management	Existing Element
P.5	Safety, Health, Hygiene and Security Management	New Element
P.6	Environmental Management	New Element
P.7	Project Change Control	Existing Element
P.8	Project Audits	New Element
P.9	Decision register	New Element
Q	**PROJECT IMPLEMENTATION PLAN**	
Q.1	Engineering / Construction Plan & Approach	Existing Element
Q.2	Project Organization	New Element
Q.3	Responsibility matrix RACI	New Element
Q.4	Document Management Plan	New Element
Q.5	Communication management plan	New Element
Q.6	Project Delivery Method	Existing Element
Q.7	Design / Construction Plan and Approach	Existing Element
Q.8	Safety Procedures	Existing Element
Q.9	Intercompany Agreements	Existing Element
Q.10	Deliverables for Design and Construction	Existing Element
Q.11	Labour and Skilled resources plan	New Element
R	**HANDOVER & OPERATIONAL READINESS**	
R.1	Commissioning plan	New Element
R.2	Start–up Requirements & plans	Existing Element (added "& plans")
R.3	Training Requirements	Existing Element
R.4	Substantial Completion Requirements	Existing Element

R.5	Deliverables for Project Commissioning / Closeout	Existing Element
R.6	Long term supply chain contracts	New Element
R.7	Resourcing & staffing for operation	New Element
R.8	Maintenance schedules	New Element
R.9	Critical spares	New Element
R.10	Start–up consumables	New Element
R.11	Operational systems and procedures to support each department	New Element
R.12	Environmental Management Plan for Operations (EMP)	New Element

4.9.2 Applying weights to the various elements of the RAT

Once the final list of elements, categories and sections was determined, along with definitions for each element, the next step was to gather information to arrive at a weighted tool. This process is depicted in Figure 4.5.

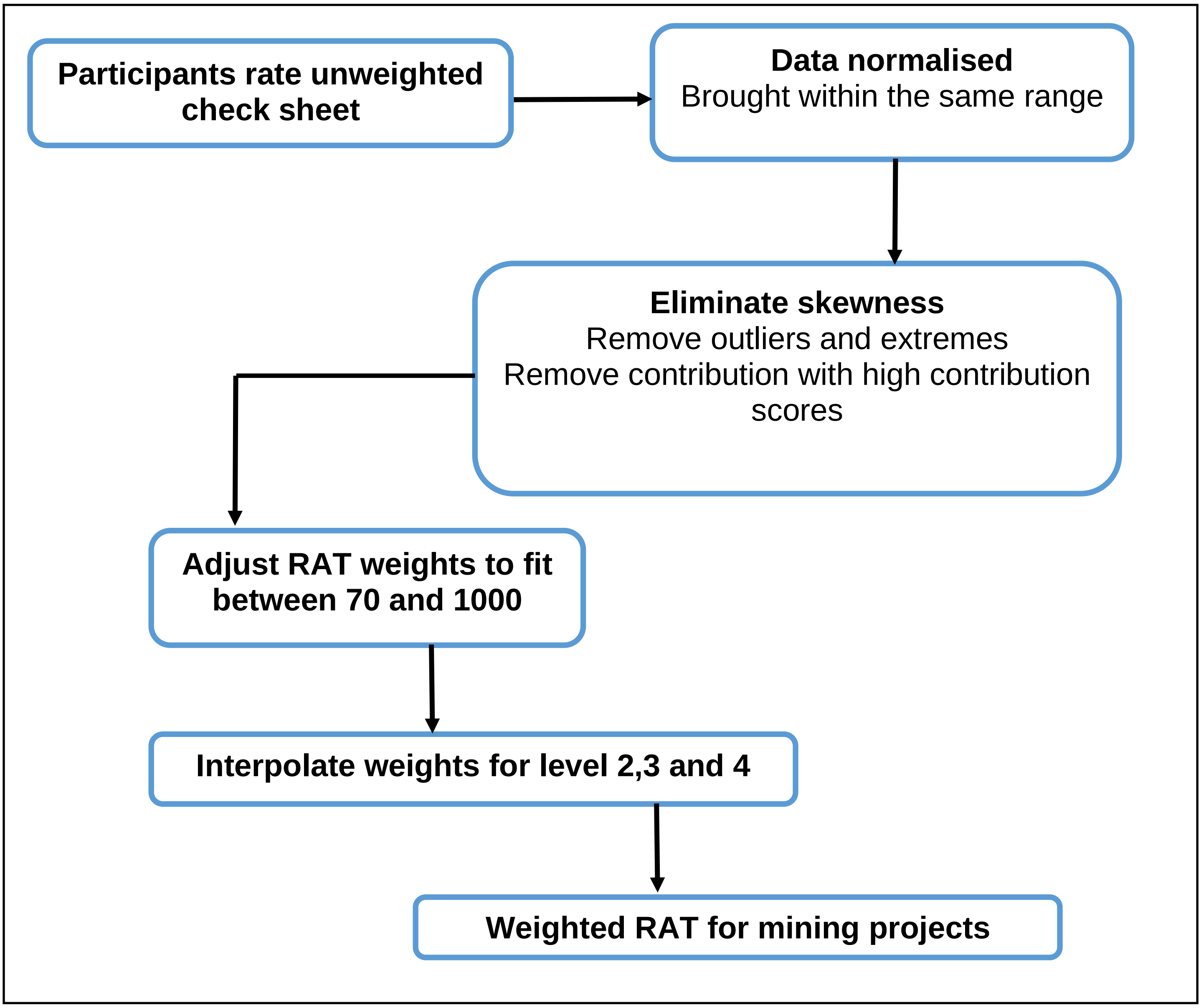


Figure 4. 5 – Process to determine weighted RAT for Mining Projects

As all the elements in the RAT did not contribute equally to the success of a project, the opinion of experts in the mining project management area were required as to the relative significance of the various elements. In the previous four PDRIs, this was mainly done via workshops. This option was discussed, but because of the relative scarcity and geographical spread of individuals with adequate experience in mining projects, it was decided to instead seek the inputs from experts via questionnaires which were to be emailed, rather than to try to gather the individuals in a central location. Emails were sent to several individuals with experience in the mining projects field. An example of the email is given in Annexure F. In total, the survey was sent to 66 individuals who had significant experience in mining projects. These individuals represented project managers, engineers, and quantity surveyors, working for large mining companies as well as EPCM companies. The email contained instructions on how to complete the questionnaire, as well as the contact details of the researcher, should any instructions be unclear. The unweighted RAT for mining check sheet was attached to the email. Instructions how to complete the questionnaire, along with an example of a completed section, was included. There was also a section to be completed by the participants, indicating the number of years of experience, as well as the value of projects in which the participant was involved.

Participants were asked to rate the relative significance of each of the 180 elements in the RAT, by allocating a value to definition level 1 and definition level 5. Definition level 1 indicates that a specific element had a complete definition. This means that the element had been thoroughly studied before seeking approval for implementation of the project. Definition level 5 indicates that there is an incomplete or poor definition of the element during the study. This means that the specific element was addressed during the study of the project. No specific scale was given to participants to use. Instead, it was left up to participants to use their own scale, as the results would be normalised once collated.

Participants were instructed to assign a % of contingency for both level 1 and level 5 definitions, based on their experience in mining projects. This meant that participants had to insert a value for level 1, which represented the level of contingency that the participant felt should be included for the specific element, if the evaluation found that the specific element's definition had been developed to a Level 1. Similarly, the participant would insert a value for Level 5, which represented the amount of contingency which the participant felt should be included for the specific element, if the specific element's definition had been developed to a level 5. Participants were not asked to supply values for level 2, 3 and 4, as these would be interpolated. Previous research had shown that definition level 2,3 and 4 trended linearly between 1 and 5 (Bingham, 2010:64).

There was an option of indicating that a specific element was not applicable. An example of the instructions is given in Figure 4.6.

Instructions for completion of Check sheet

1. Consider a typical project in the mining industry. Consider that you had been asked to estimate the project cost just prior to the detail design phase of the project

2. Assign a contingency amount to each element. If the element was completely defined, note the contingency amount under definition level 1

3. Similarly, assign a contingency amount to each element under level 5 if little to no definition exists.

4. Do not assign contingencies for definition levels 2, 3 and 4, as these will be interpolated

The contingency should represent the amount of money (as a % of total project cost) that would be necessary to offset uncertainties to project implementation

Figure 4. 6 – Instructions given to participants completing the unweighted check sheet

		Definition Level					
A	PROJECT STRATEGY	0	1	2	3	4	5
A.1	Project Justification		2%				7%
A.2	Project Charter and Mandate		3%				11%
A.3	Governance and control (internal approval process defined)		5%				12%
A.5	Project Strategy		1%				9%
A.6	Strategic fit of project in organisation		0%				5%
A.7	Due diligence		2%				6%
A.8	Partnership, joint ventures and shareholder buy in		5%				11%

0 = Not applicable
1 = Complete definition
2 = Minor deficiencies
3 = Some deficiencies
4 = Major deficiencies
5 = Incomplete or poor definition

Participants were asked to complete the weighting check sheet, as well as the additional information regarding the experience of the participant, and return the information via email.

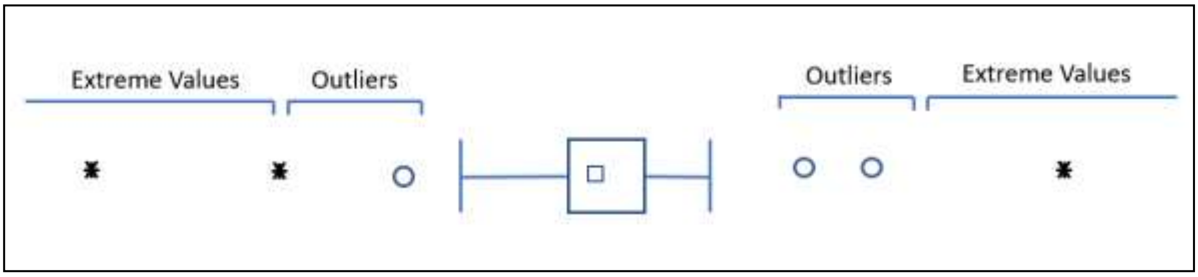
In total, 20 responses were received, of which 18 were used. This equated to a response rate of 27%, which for an expert population and input, is considered to be sufficient. The two responses which were not included were not completed in the prescribed manner, and therefore, the data could not be incorporated in the study. The 18 participants represented a combined experience of 410 years, with projects to the value of R 898 billion. The average participant had 20,5 years of experience and averaged a lifetime project value of R44,9 billion.

To use the data gathered through the questionnaires, the data first had to be normalised. Because the individual participants used arbitrary scales, the data needed to be brought to within the same ranges. All the participants used 0 as the absolute minimum. Thus, the lower end of the scale was fixed. However, the upper end of the scale varied significantly between the individual participants. To be able to compare the individual responses, the individual data sets had to be brought to within the same range, between 0 and 100. The first step in this process entailed the calculation of individual modifiers for each of the participants. This was done by dividing the largest value used by the participant, into 100. This individual modifier was then multiplied with all the weights assigned to the individual elements, thereby bringing all the responses to within the same range of between 0 and 100. If all the responses of a participant were found to be between 0 and 20, the individual modifier for this participant was determined as 100 / 20 = 5. The individual responses were then multiplied by the individual modifier (5). In this manner, all the responses were distributed between 0 and 100.

The list indicating the individual scores by all participants before normalisation is shown in Annexure G. This list also shows the individual modifiers used to normalise the contributions. The list of individual scores after normalisation is shown in Annexure H.

Before the normalised values could be used to calculate the weights of the various elements, it was essential to analyse the individual contributions to determine if any of the contributions were skewing the data. This was done by calculating the descriptive statistics, namely the mean, median, standard deviation, variance, and skewness, of each element. Further analysis of the data showed that the inputs from some of the participants were skewing the data.

In previous studies (Bingham, 2010:66), boxplots were used to determine the outliers and extremes. A boxplot is a graphical representation of the data and some of the descriptive statistics. Figure 4.7 indicates a typical boxplot.



Source: Statista (2018)

Figure 4. 7 – Typical box plot

A typical boxplot will indicate the data on a vertical or horizontal line. The median of the data, as well as the 25th percentile and 75th percentile value, will be indicated. The difference between the 75th percentile value and 25th percentile value is the *box length*.

To determine the number of outliers and extremes, the limits of outliers and extremes first needs to be calculated. Extremes are defined as those values for which the following conditions hold:

The data point value > 75th percentile value + (2 x box length)

The data point value < 25th percentile value – (2 x box length)

Outliers are defined as those values for which the following conditions hold:

- The data point value > 75th percentile value + (1.5 x box length)
- The data point value < 25th percentile value – (1.5 x box length)
- The data point does not fall into the extreme range

For the RAT for Mining Projects, it was decided to use the same principle as described above (and which was used in the previous PDRIs) to determine outliers and extremes but to carry out the physical calculation instead of following the graphical technique. For all the elements, the medians, interquartile range and outlier and extreme boundaries were calculated using the formulas listed above. This was then used to determine the number of outliers and extremes for all datasets. The results of this calculation are shown in Annexure I.

An example of an outlier, as depicted in Annexure I, is the contribution of Participant 9 under Element *A.5 – Project Strategy*. The median of this dataset is 42%, with the 75th percentile value = 52, and the 25th percentile value = 27. This means that the box length is (52 – 27) = 25. Outliers are defined as those with a value higher than 52+ (25 x 1.5) = 89; or value lower than 27 – (25 x 1.5) = –11. Any individual data point higher than 89 or lower than –11 is thus an outlier and is seen as skewing the data. As Participant 9 contributed a value of 100, which is higher than 89, this data point is seen as an outlier.

An example of an extreme value, as depicted in Annexure I, is the contribution of Participant 1 under Element *F.8 – Contractual considerations*. The median of the data set is 33, with the 75th percentile value = 42, and the 25th percentile value = 27. This means that the box length is (42 – 27) = 15. Extreme values are defined as those with a value higher than 33 + (2 x 15) = 63; or lower than 33 – (2 x 15) = 3. Any individual data point higher than 63 or lower than three is thus skewing the data. As Participant 1 has indicated a value of 100, which is higher than 63, this data point is seen as an extreme.

In total, 66 outliers and six extremes were identified in this manner. To identify individual contributions which could be skewing the results, individual contribution scores were calculated for each participant. The formula to calculate an individual contribution score was:

Contribution score = 3 x (Number of extremes) + 1 x (Number of outliers)

An example of the calculation of the individual contribution score of the participants, is that of Participant 1. As shown in Annexure I, Participant 1 had a total of 30 outliers, and 3 extremes. The Contribution score of Participant 1 was this (3 x 3) + (1 x 30) = 39.

The table indicating the contribution scores of all participants is shown in Table 4.8. Those participants with a low contribution score had few or no outliers or extremes in their datasets and were thus not contributing significantly to skewing the data. Participants with a high contribution score were contributing significantly to skewing the data.

Table 4. 8 – Calculation of individual contribution scores of participants

	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	P 13	P 14	P 15	P 16	P 17	P 18	P 19	**Total**
Outliers	30		2	4		4	1	4	2			1			2	1	10	1	4	**66**
Extremes	3							1		1	1									**6**
Contribution score	**39**	**0**	**2**	**4**	**0**	**4**	**1**	**7**	**2**	**3**	**3**	**1**	**0**	**0**	**2**	**1**	**10**	**1**	**4**	

Bingham (2010:67) mentions several options to deal with participants who are identified as skewing the data. These include:

a) Not removing the data supplied by any participants, by deciding that those contributions were still valid;
b) Removing the entire contribution (dataset) of those individuals with a very high contribution score;
c) Keeping all the individual contributions but removing those individual data points which were skewing the data sets. This would entail removing outliers and extremes from the data set;
d) A combination of b and c above, where the entire contribution of individuals with high contribution scores was removed, as well as those individual data points from other contributors which were outliers or extremes; and
e) Leave the data points calculated as outliers and remove only those data points identified as extremes.

It was decided to go with option d above. This would mean removing the entire contribution of some individuals who had a high individual contribution score, as well as the extreme and outlier data points of all other contributors. The inputs of one individual with an individual contribution score of 39 was removed, as well as a total of 66 outliers and six extremes.

Once the extremes and outliers were dealt with, the final RAT scores for the various elements could be calculated. This was done in two stages. The first stage entailed calculating the final values for all level 5 scores, and the second stage was achieved by interpolating the values for levels to 4.

To calculate the final level 5 scores, the average of all the remaining datasets had to be calculated. As some data points had been removed as outliers or extremes, this had to be accounted for when calculating the average weights of the individual elements. To overcome this, the sums of the individual elements were divided by the number of remaining individual data points, considering that some of the data points had been removed. The results of this can be seen in Annexure J. This table shows the average of all contributions before the removal of outliers and extremes, as well as afterwards. The difference (delta) between the two columns is also shown. On average, the upper (definition level 5) value for each element was reduced by 0.6% through this exercise.

At this stage, the weighted data, although corrected for extremes and outliers, still did not encompass the same range as the previous PDRIs. The previous PDRIs all ranged between 1000 points (indicating no definition for any of the elements) and a lower limit of around 70. This meant that a project study when there is no definition yet to any of the elements would have a PDRI score of 1000. When all the elements were thoroughly studied, the PDRI score of the project would be 70. The lower value of 70 was determined in the previous studies because the previous PDRIs all had around 70 elements. The RAT for Mining Projects consists of 180 elements. There were thus two options available going forward:

Option 1: Adjust the RAT weights to fit between 1000 and 180 to represent the number of elements.

Option 2: Adjust the RAT weights to fit between 1000 and 70 to be in line with previous PDRIs.

Because the PDRI is an internationally accepted and widely used tool, it was decided to use option two. This would make it easier for those using the tool to interpret the RAT score, as it is in line with the previous four tools to which individuals have become accustomed. The weighted RAT was adjusted to fit between the range of 1000 and 70 in the following manner:

The sum of all level 1 weights was totalled and divided by 70. This constant was then multiplied by the level 1 weight of each element. The sum of all the level 5 weights was divided by 1000. This constant was then multiplied by the level 5 weight of each element. This meant that the weights had been modified to fit between 70 and 1000. A list depicting the values before the adjustment and after the adjustment (between 70 and 1000), as well as the modifying factors, are depicted in Annexure K.

Once the final values for all the level 5 and level 1 scores had been calculated, the values for levels 2, 3 and 4 could be interpolated. This was done by basic interpolation of the data. The weights were calculated as follows:

Level 2 weight = ((Level 5 weight – Level 1 weight) / 4) + level 1 weight

Level 3 weight = ((Level 5 weight – Level 1 weight) / 4) + level 2 weight

Level 4 weight = ((Level 5 weight – Level 1 weight) / 4) + level 3 weight

This represented a direct linear interpolation of the data. The results of the interpolation are shown in Annexure L. This effectively depicts the weighted RAT tool. By producing this tool, Proposition 1 was proven.

Proposition 1 – "*A fixed and definite list of issues related to Scope Definition of mining projects can be developed.*" This proposition was tested by producing the draft tool and sharing it with various experts. Their feedback was incorporated into the list of Scope Definition elements. The analysis of the tool and some of the significant findings are discussed in Chapter 5.

4.9.3 Summary of Research Methodology to create the weighted RAT

The methodology followed to finalize the list of elements, was based on Mixed Method Research. The initial list of elements to be used in the RAT for Mining Projects was compiled using a literature review, where the existing RATs as well as literature regarding mining projects were consulted. This resulted in a draft, unweighted RAT for Mining check list, which consisted of several elements.

The draft unweighted list of elements was sent to representatives of large mining houses, and their comments was incorporated. The sheet updated, before it was sent to EPCMs, who were also asked to comment on the draft sheet. By incorporating the feedback of the EPCM firms, the draft list of elements was finalized, although weights were not yet assigned to the various elements.

To assign weights to the various elements of the RAT, experienced mining project practitioners were asked to assign weights (in the form of contingencies) to each of the 180 elements. The data was checked for normality, and weights were calculated for each of the elements. In this manner, a weighted list of elements was created, which established a RAT for Mining Projects.

In the next chapter, the manner in which the RAT for Mining Projects was validated, will be discussed, along with the findings of the study.

5. DISCUSSION OF THE OUTCOMES OF THE STUDY

The previous chapter examined the methodology that was used to create the previous four PDRIs, as well as the RAT for Mining Projects. This included the establishment of the final list of elements in the unweighted check sheet, as well as the process of assigning weights to the RAT tool.

In this chapter, the outcome of the study will be discussed. The various Sections, Categories and Elements will be examined and analysed. This is followed by a discussion of the validation process, and the outcomes of this process.

5.1 The RAT for Mining Projects

The RAT for Mining Projects was developed through the research steps conducted in the previous chapter. The final RAT consists of 180 elements, which are divided into four Sections and 18 Categories. The total of the weights of each section and category, as well as the average weight of each section and category as extracted from the completed, weighted RAT for Mining Projects (see Annexure K), are depicted in Table 5.1.

The four sections of the RAT for Mining Projects progress from a high–level, more strategic perspective, to a more detailed level. *Section I* deals with the basis for the project decision and contains categories such as project strategy, project feasibility, the resource estimate, the operating philosophy, and the analysis of the market and strategy. *Section II* starts to look at the details of the project, with regards to the scope, social and environmental considerations, and other project considerations, including the schedule and completion risks. *Section III* looks at the design of the project as it pertains to the construction phase, and contains categories such as the site information, project design parameters, and value improving practices. The last section, *Section IV*, considers the implementation approach and contains categories such as procurement strategy, project controls, the project implementation plan, and handover and operational readiness planning.

Table 5. 1 – Average and total weights per Section and Category

RAT for Mining Projects		Sum	Average
SECTION I – BASIS OF PROJECT DECISION		**351,29**	**6,51**
A	PROJECT STRATEGY	45,19	6,46
B	COUNTRY RISK	55,63	6,18
C	PROJECT FEASIBILITY	60,77	7,60
D	RESOURCE AND RESERVE STATEMENT	47,64	7,94
E	LIFE OF MINE PLANNING	60,65	6,06
F	OPERATING PHILOSOPHY	45,38	5,67
G	MARKET ANALYSIS AND STRATEGY	36,03	6,00
SECTION II – PROJECT DETAILS		**215,16**	**5,82**
H	PROJECT CONSIDERATIONS	87,11	6,70
I	PROJECT SCOPE	28,08	7,02
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	99,97	5,00
SECTION III – DESIGN FOR CONSTRUCTION		**230,36**	**4,90**
K	SITE INFORMATION	43,05	4,78
L	PROJECT DESIGN PARAMETERS	142,14	5,47
M	VALUE IMPROVING PRACTICES	45,17	3,76
SECTION IV – IMPLEMENTATION APPROACH		**203,21**	**4,84**
N	PROCUREMENT STRATEGY	26,19	4,36
O	DELIVERABLES	16,64	4,16
P	PROJECT CONTROLS	49,58	5,51
Q	PROJECT IMPLEMENTATION PLAN	54,24	4,93
R	HANDOVER & OPERATIONAL READINESS	56,56	4,71

Section 1, with categories and elements, as well as weights for the various definition levels (1 – 5) is depicted in Table 5.2. The Section with the highest total weights (351,27) as well as the highest average weight (6,51) is Section I – Basis for project decision. This section evaluates the project from a strategic perspective. Table 5.3 depicts the results if the categories within the various sections are sorted based on the total weights within the categories, while Table 5.4 depicts the results if the categories are sorted according to the average weights within the categories.

Table 5. 2 – Section I of the completed RAT

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		**Weight**
A	**PROJECT STRATEGY**	
A.1	Project Justification	7,74
A.2	Project Charter and Mandate	6,15
A.3	Governance and control (internal approval process defined)	6,90
A.5	Project Strategy	5,41
A.6	Strategic fit of project in organisation	5,52
A.7	Due diligence	6,85
A.8	Partnership, joint ventures, and shareholder buy–in	6,62
B	**COUNTRY RISK**	
B.1	Social Issues	7,92
B.2	Geo–political risks	6,56
B.3	Fiscal stability agreement	5,29
B.4	Social License to Operate	5,15
B.5	Violence and terrorism	6,02
B.6	Ability to appoint expatriates	5,79
B.7	Procurement of local and foreign materials, services, and equipment	6,22
B.8	Country infrastructure (power, roads, rail, water ports)	6,66
B.9	Custom duties & logistic routes	6,03
C	**PROJECT FEASIBILITY**	
C.1	Resources secured (including land and mineral rights)	9,30
C.2	Financing secured (Internal, external, equity, debt)	7,77
C.3	Business Plan	6,69
C.4	Economic Analysis	6,53
C.5	Affordability / Feasibility	7,55
C.6	Contingencies (Capex & Opex)	10,22
C.7	Basis of Estimate	7,29
C.8	Scenario planning	5,41
D	**RESOURCE AND RESERVE STATEMENT**	
D.1	Metallurgical yield	9,33
D.2	Reserve risks (including modifying factors)	9,81
D.3	Grade engineering / control	7,05
D.4	Prospect drilling standard / guideline	6,58
D.5	Geological conditions (Geological model, structure, qualities)	8,91
D.6	Hydrogeology	5,96

E	**LIFE OF MINE PLANNING**	
E.1	Mine design criteria	6,88
E.2	Shaft/ramp design & men and material logistics	6,50
E.3	Mining methods (drilling, blasting, loading, hauling)	5,68
E.4	Equipment selection to fit geological conditions and mining method	5,95
E.5	Life–of–mine plan	6,62
E.6	Waste management plan	4,62
E.7	Ultimate pit limits designed	5,02
E.8	Economic block values determination	7,34
E.9	Beneficiation facilities LOM plan	5,66
E.10	Materials handling LOM plan	6,36
F	**OPERATING PHILOSOPHY**	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	4,84
F.2	Productivity / efficiency benchmarks	4,44
F.3	Operating costs	8,58
F.4	Production risks	7,50
F.5	Catalogue of operating plans	4,43
F.6	Haul roads	5,45
F.7	Transportation strategy	5,13
F.8	Contractual considerations	5,01
G	**MARKET ANALYSIS AND STRATEGY**	
G.1	Market Strategy & Sales Agreements	7,08
G.2	Price risks	8,52
G.3	Demand risks & replacement products / technologies	7,73
G.4	Value–Analysis Process	5,22
G.5	Hedging	3,89
G.6	Competitor analysis	3,58

From Table 5.3, *Project Feasibility, Life of Mine Planning* and *Country Risk* carry the highest total weight in Section I. It would, therefore, be prudent for anyone involved in a mining project study, to pay special attention to these categories. They could potentially impact the project significantly. *Project Feasibility* includes elements such as securing the resource, including land and mineral rights (LRC Centre, 2016), whether financing is secured (Benning, 2000), the economic analysis (Csiminga and Iloiu, 2007) and scenario planning (Ausimmbulletin, 2015).

Table 5. 3 – Categories sorted within sections, based on total weights per category.

RAT for Mining Projects		Sum	Average
SECTION I – BASIS OF PROJECT DECISION		**351,29**	**6,51**
C	PROJECT FEASIBILITY	60,77	7,60
E	LIFE OF MINE PLANNING	60,65	6,06
B	COUNTRY RISK	55,63	6,18
D	RESOURCE AND RESERVE STATEMENT	47,64	7,94
F	OPERATING PHILOSOPHY	45,38	5,67
A	PROJECT STRATEGY	45,19	6,46
G	MARKET ANALYSIS AND STRATEGY	36,03	6,00
SECTION II – PROJECT DETAILS		**215,16**	**5,82**
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	99,97	5,00
H	PROJECT CONSIDERATIONS	87,11	6,70
I	PROJECT SCOPE	28,08	7,02
SECTION III – DESIGN FOR CONSTRUCTION		**230,36**	**4,90**
L	PROJECT DESIGN PARAMETERS	142,14	5,47
M	VALUE IMPROVING PRACTICES	45,17	3,76
K	SITE INFORMATION	43,05	4,78
SECTION IV – IMPLEMENTATION APPROACH		**203,21**	**4,84**
R	HANDOVER & OPERATIONAL READINESS	56,56	4,71
Q	PROJECT IMPLEMENTATION PLAN	54,24	4,93
P	PROJECT CONTROLS	49,58	5,51
N	PROCUREMENT STRATEGY	26,19	4,36
O	DELIVERABLES	16,64	4,16

Table 5.4 indicates that the category in Section I with the highest average weight is *Resource and Reserve Statement.* As this category evaluates the estimate and evaluation of the resource to be mined, it makes sense that the elements in this category carry a high average weight. Some of the elements in this category include the *Metallurgical Yield*, the *Reserve Risk* which is an indication of the confidence in the reserve estimate (Morley, 1999), the *Prospect Drilling Standards* which is a guideline for the sampling procedures and tests based on the nature of the ore (Kennedy et al. 1990) and *Hydrogeology* which is an analysis of the impacts caused by the presence of mining on the surface and subsoil water (SRK consulting, 2018).

Table 5. 4 – Categories sorted within sections, based on average weights per category.

RAT for Mining Projects		Sum	Average
SECTION I – BASIS OF PROJECT DECISION		**351,29**	**6,51**
D	RESOURCE AND RESERVE STATEMENT	47,64	7,94
C	PROJECT FEASIBILITY	60,77	7,60
A	PROJECT STRATEGY	45,19	6,46
B	COUNTRY RISK	55,63	6,18
E	LIFE OF MINE PLANNING	60,65	6,06
G	MARKET ANALYSIS AND STRATEGY	36,03	6,00
F	OPERATING PHILOSOPHY	45,38	5,67
SECTION II – PROJECT DETAILS		**215,16**	**5,82**
I	PROJECT SCOPE	28,08	7,02
H	PROJECT CONSIDERATIONS	87,11	6,70
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	99,97	5,00
SECTION III – DESIGN FOR CONSTRUCTION		**230,36**	**4,90**
L	PROJECT DESIGN PARAMETERS	142,14	5,47
K	SITE INFORMATION	43,05	4,78
M	VALUE IMPROVING PRACTICES	45,17	3,76
SECTION IV – IMPLEMENTATION APPROACH		**203,21**	**4,84**
P	PROJECT CONTROLS	49,58	5,51
Q	PROJECT IMPLEMENTATION PLAN	54,24	4,93
R	HANDOVER & OPERATIONAL READINESS	56,56	4,71
N	PROCUREMENT STRATEGY	26,19	4,36
O	DELIVERABLES	16,64	4,16

Section II – Project Details is the section with the third–highest total weight (215,16) and the second–highest average weight (5,82).s. In this section, the details of the project are unpacked. Section II, with categories and elements, as well as weights for the various definition levels (1 – 5) is depicted in Table 5.5.

From Table 5.3, *Social and Environmental Requirements* is the category carrying the biggest total weight in Section II. It is followed by *Project Considerations*, and then *Project Scope*. *Social and Environmental Requirements* and *Project Considerations* should thus be adequately addressed during the project study, as these Categories can have the most significant impact on the project, in this Section. *Social and Environmental Requirements* include elements such as having *Relocation Action Plans* in place. This includes ensuring that a plan is in place and specifying the actions and procedures to resettle and compensate affected people and communities adequately. Another element of this category is the *Sustainability Operating Plan*, which addresses the long–term achievement of Social License to Operate while ensuring maximum returns for the company (SRK Consulting, 2017).

Table 5.4 shows that the Category with the highest average weight in Section II is *Project Scope*. Some of the Elements of this Category include the *WBS and WBS Dictionary* and the *Project Scope Definition*. According to Sabyasachi (2017), the *WBS and WBS Dictionary* contain detailed information regarding each element in the Work Breakdown Structure (WBS), including work packages and control accounts.

Table 5. 5 – Section II of the RAT

SECTION II – PROJECT DETAILS		Weight
H	**PROJECT CONSIDERATIONS**	
H.1	Expected Project Life Cycle	6,02
H.2	Assumption register	4,70
H.3	Completion risks	5,53
H.4	Project Design Criteria	6,89
H.5	Scope of Work Overview	9,38
H.6	Project Schedule	10,24
H.7	Project Cost Estimate	10,83
H.8	Investment Studies & Alternatives Assessments	6,10
H.9	Key Team Member Coordination	5,14
H.10	Evaluation of Compliance Requirements	6,68
H.11	Lead / Discipline Scope of Work	6,48
H.12	Housing and transport of employees	4,59
H.13	Risk or impact on other projects / divisions	4,53
I	**PROJECT SCOPE**	
I.1	Project Objectives Statement	5,92
I.2	Site Characteristics Available vs. Required	5,38
I.3	Project Scope Definition	8,86
I.4	WBS and WBS Dictionary	7,93

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	
J.1	Unique mine closure plan	4,92
J.2	Land use plan post operations	3,83
J.3	Social expectations register	4,80
J.4	Relocation Action Plan	7,38
J.5	Environmental expectations register	4,93
J.6	Political expectations register	4,71
J.7	Legal compliance register	6,13
J.8	HSE risk register	4,80
J.9	Community risk register	5,97
J.10	Business risk register	4,94
J.11	Developmental opportunity register	4,42
J.12	Sustainability operating plan	4,54
J.13	Stakeholder engagement plan	4,98
J.14	Mine closure financial provision plan	5,52
J.15	Closure plan review and updates scheduled during Life of Mine plan	4,42
J.16	Social investment plan	5,12
J.17	Economic diversification plan	4,16
J.18	Existing Environmental Conditions	4,55
J.19	Environmental Process determined	4,66
J.20	Environmental management plan	5,18

Section III – Design for Construction has the second–highest total weight (230,36), as well as the third–highest average weight per section (4,90). This Section deals with the design concept and the requirements of the site where the project is to be constructed. Section III, with categories and elements, as well as weights for the various definition levels (1 – 5), is depicted in Table 5.6.

Table 5.4 indicates that *Project Design Parameters* is the Category with the highest total weight in Section III, followed by *Value Improving Practices. Project Design Parameters* contains elements such as the *Design Criteria*, which are the design guidelines for the various disciplines involved in the mining project. The *Control Philosophy and Systems* is another Element in this Category. This important Element defines the level and type of process automation, along with the system which will deliver it (Eng–Tips.com, 2018).

Table 5. 6 – Section III of the RAT

SECTION III – DESIGN FOR CONSTRUCTION		
K	**SITE INFORMATION**	
K.1	Site Layout	5,16
K.2	Site Surveys	4,34
K.3	Governing Regulatory Requirements	5,94
K.4	Utility Sources with Supply Conditions	5,72
K.5	Fire Protection, emergency procedure & Safety Considerations	4,32
K.6	Special Water and Waste Treatment Requirements	4,34
K.7	Property Descriptions	2,88
K.8	Right–of–Way Mapping & Site Issues	3,62
K.9	Land Rights	6,75
L	**PROJECT DESIGN PARAMETERS**	
L.1	Design Criteria	5,64
L.2	Civil/Site Design	5,70
L.3	Geotechnical investigation for structures	6,36
L.4	Architectural Design	4,61
L.5	Structural Design	5,73
L.6	Mechanical Design	5,70
L.7	Electrical Design	6,10
L.8	Constructability Analysis	6,20
L.9	Process Design	7,89
L.10	Specifications	5,62
L.11	Speciality Items List	5,03
L.12	Instrument Index	5,03
L.13	Control Philosophy & systems	5,44
L.14	Logic Diagrams	5,14
L.15	IM (information management)	4,88
L.16	Control of Access	4,38
L.17	Safety & Hazards	5,35
L.18	Operations/Maintenance	5,79
L.19	Ventilation Engineering	5,58
L.20	Rock Engineering	5,89
L.21	Water balances	5,82
L.22	Energy efficiency / carbon footprint	4,82
L.23	Tailings handling and storage	6,06
L.24	Stormwater handling / surface hydrology	5,31
L.25	Internal technical audits	4,04
L.26	External technical audits	4,03

M	VALUE IMPROVING PRACTICES	
M.1	Process Simplification	4,35
M.2	Design & Material Alternatives Considered/Rejected	4,19
M.3	Technology trends	4,28
M.4	Design to capacity	4,20
M.5	Classes of facility quality	3,19
M.6	Energy optimisation	3,54
M.7	Waste minimisation	3,91
M.8	3D / 4D design	4,29
M.9	Cleaner Production	3,17
M.10	Innovation and knowledge management planning	3,49
M.11	Six Sigma	3,39
M.12	Lean Manufacturing	3,18

Value Improving Practices refers to a list of 12 Elements which includes *Classes of Facility Quality, Design to Capacity* and *Waste Minimization. Classes of Facility Quality* establishes the quality of the facility that is required, based on the project lifecycle and other criteria (VM Services Pty Ltd, 2012). *Design to Capacity* is a structured methodology for addressing design capacity against business needs and eliminating “hidden capacity”. (McCuish and Kaufman, 2002). *Waste Minimization* involves the reduction of waste at the source and the re–use of waste for cost–effectiveness (The Team Focus Group, 2018).

Table 5.4 shows that *Project Design Parameters,* has both the highest total weight and the highest average weights per element, in Section III. However, *Site Information* has a higher average weight per Element than *Value Improving Practices. Site Information* contains Elements such as *Site Surveys*, which examines the degree to which the proposed site has been surveyed, and *Utility Sources with Supply Conditions*, the extent to which services such as electricity and water are available at the site.

Section IV – Implementation Approach has the lowest total weight (203,21), as well as the lowest average weight per section (4,84). This section deals with implementation and handover procedures. Section 4, with categories and elements, as well as weights for the various definition levels (1 – 5), is depicted in Table 5.7.

Table 5.3 and Table 5.4 indicate that the same three Categories are in the top three when considering total Category weight, and average Element weight per Category, although in a different order. When considering total Category weight in Section IV, *Handover and Operational Readiness* has the highest weight, followed by *Project Implementation Plan.* When evaluating the average weights per Element, *Project Controls* has the highest average weight, followed by *Project Implementation Plan* and *Handover and Operational Readiness*. These three Categories appear to be important to address during the study of a mining project. *Handover and Operational Readiness* includes the *Commissioning Plan,* which outlines the overall process, schedule, organisation, responsibilities, and documentation for the commissioning process. It also includes *Training Requirements*, which addresses the training of operational and maintenance personnel to take over the project. *Maintenance Schedules* is another Element in this Category, which indicates how, by whom, and when, the plant should be maintained.

Table 5. 7 – Section IV of the RAT

SECTION IV – IMPLEMENTATION APPROACH		
N	**PROCUREMENT STRATEGY**	
N.1	Identify Long Lead/Critical Equipment and Materials	4,82
N.2	Procurement Procedures and Plans	3,63
N.3	Procurement Responsibility Matrix	3,16
N.4	Draft contracts & proforma bidders pack	4,35
N.5	Contracting strategy	5,58
N.6	Procurement operation plan (POP)	4,65
O	**DELIVERABLES**	
O.1	CADD/Model Requirements	3,85
O.2	Deliverables Defined	5,47
O.3	Distribution Matrix	3,23
O.4	Documentation/Deliverables	4,09

P	**PROJECT CONTROLS**	
P.1	Project Quality Assurance and Control	5,23
P.2	Project Cost Control	6,51
P.3	Project Schedule Control	6,83
P.4	Risk Management	5,74
P.5	Safety, Health, Hygiene and Security Management	5,02
P.6	Environmental Management	5,12
P.7	Project Change Control	6,88
P.8	Project Audits	3,44
P.9	Decision register	4,82
Q	**PROJECT IMPLEMENTATION PLAN**	
Q.1	Engineering / Construction Plan & Approach	6,03
Q.2	Project Organization	5,78
Q.3	Responsibility matrix RACI	4,75
Q.4	Document Management Plan	3,44
Q.5	Communication management plan	3,67
Q.6	Project Delivery Method	5,26
Q.7	Design / Construction Plan and Approach	5,65
Q.8	Safety Procedures	4,68
Q.9	Intercompany Agreements	3,69
Q.10	Deliverables for Design and Construction	6,29
Q.11	Labour and Skilled resources plan	4,99
R	**HANDOVER & OPERATIONAL READINESS**	
R.1	Commissioning plan	5,89
R.2	Start–up Requirements & plans	5,43
R.3	Training Requirements	4,69
R.4	Substantial Completion Requirements	5,01
R.5	Deliverables for Project Commissioning / Closeout	5,12
R.6	Long term supply chain contracts	4,69
R.7	Resourcing & staffing for operation	4,81
R.8	Maintenance schedules	3,10
R.9	Critical spares	4,13
R.10	Start–up consumables	3,95
R.11	Operational systems and procedures to support each department	4,31
R.12	Environmental Management Plan for Operations (EMP)	5,42

The *Project Implementation Plan* Category deals with the way the project will be executed. This includes Elements such as *Project Organisation* (The organisational hierarchy, with the roles and responsibilities of everyone clearly defined); *Safety Procedures* (Procedures designed to keep everyone safe while reducing stress associated with the work area (Root, 2018)); and *Labour and Skilled Resources Plan* (A plan detailing the engagement/sourcing and training of adequate skilled staff to address the requirements of the project). *Project Controls* encompasses Elements such as *Quality Assurance and Control*, *Project Cost Control* and *Project Schedule Control.* It also looks at *Risk Management* and *Project Change Control.*

The results of this analysis clearly show that the Section with the most significant potential impact on mining project success, during the project study, is *Section I – Basis of Project Decision*. This is followed by *Section II – Project details, Section III – Design for Construction*, and *Section IV – Implementation Approach,* in that order. This should be the order of priority when a mining project is studied, as the higher total and higher average weights of the elements in the higher–ranked Categories will result in a more significant reduction of the RAT score.

In the preceding section, the relative importance of the various Categories and Sections were discussed. Before proceeding to the discussion of the results of the validation process, the value of some of the individual Elements should be considered. Table 5.8 shows the 10 Elements with the highest weights. These Elements were judged by the participants in the study as having the biggest potential impact on the outcome of a mining project, if not adequately addressed during the study.

Table 5. 8 – Highest weighted elements

H7	Project Cost Estimate	10,83
H6	Project Schedule	10,24
C6	Contingencies (Capex & Opex)	10,22
D2	Reserve risk (including modifying factors)	9,81
H5	Scope of Work Overview	9,38
D1	Metallurgical yield	9,33
C1	Resources secured (including land and mineral rights)	9,3
D5	Geological conditions (Geological model, structure, qualities)	8,91
I3	Project Scope Definition	8,86
F3	Operating costs	8,58

Project Cost Estimate is the Element with the highest weight, followed by *Project Schedule.* The *Project Cost Estimate* is the approximation of the cost of a project and is the end product of the estimating process (Wikipedia, 2018c). Of the three quantitative performance indicators which were calculated during the validation portion of the study, Cost Performance and Schedule Performance have very similar coefficients as well as R^2 values, while that of Change Performance is significantly higher. The R^2 values and coefficients of Cost, Schedule and Change Performance are depicted in Table 5.9.

Table 5. 9 – R^2 values and coefficients of quantitative indicators

Performance indicator	R^2	X Coefficient
Schedule Performance	0.079	0.00053
Cost Performance	0.086	0.00046
Change Performance	0.3626	0.00081

A potential explanation for this apparent irregularity could be found in the way that Project Cost Estimates and Schedule Estimates for mining projects are compiled. Depending on the Supply Chain and Implementation approach of the study, the base estimate for a mining project will be determined either through tendering, firsts principle calculations, or some other method. Once the base estimate has been established, it is custom in mining projects to add several costs to the base estimate, to make up the Project Cost Estimate. These may include Owner's Cost, Consultants (other than the contractors carrying out the construction work) and provisions for escalation. Allowance is normally made for contingencies. Contingencies are the amount of money allowed in the Project Cost Estimate to cover eventualities. It is typically calculated as a percentage of the overall cost estimate. Often, contingencies are calculated using a Quantitative Risk Assessment (QRA). A Quantitative Risk Assessment (QRA) in project management is the process of expressing the impact of risk on the project in numerical terms (Projectlink, 2018). When carrying out a QRA, three types of risk are normally considered:

- Estimation risk, which evaluates the estimation accuracy based on:
  - Level of project definition;
  - Method of measurement; and
  - Method of pricing.
- Project Risk, which evaluates the intrinsic risk in the project; and
- Systemic Risk, which evaluates risks associated with the system, organisation, and processes. This could include stakeholder alignment, project location, labour intensity, and other factors.

A Monte Carlo Simulation is conducted to simulate the variance in cost and time resulting from the three risks, and contingency values are determined. By conducting a QRA and adding a contingency to the *Project Cost Estimate* and *Project Schedule*, the risk pertaining to low levels of project definition is addressed in the Project Cost Estimate and Project Schedule. This is further explored later in this chapter when the results of the validation process are discussed.

Project Schedule is the Element with the second highest weight. This indicates that the maturity of the *Project Schedule* during the study is the 2nd most significant contributor during the study phase, to project success. When the Schedule Performance was evaluated in the previous chapter, a positive correlation was found between a lower RAT score (better project definition) and project duration. Because contingency is also calculated for schedule variance, the risk relating to *Project Schedule* due to incomplete Project Scope Definition is accounted for in the QRA process. This could account for the relatively low correlation between the RAT score and the Schedule Performance. This will be discussed further later along with the results of the validation process are discussed.

The Element with the 3rd biggest value is Contingencies (Capital and Operational cost). Contingencies are mostly calculated using the QRA process described previously and added to the *Project Cost Estimate* and *Project Schedule*. Depending on the specific way the QRA is conducted, and certain assumptions regarding the relative risk and the impact thereof on cost and time, the variability of Cost Performance and Schedule Performance could be explained by the variability in the method of calculating contingencies. A visual inspection of Figure 5.1, which depicts the Cost Performance vs RAT score, indicates that the risk relating to incomplete project studies are addressed through the QRA process. There is still a measure of the correlation between the RAT score and the Cost Performance of a project, however.

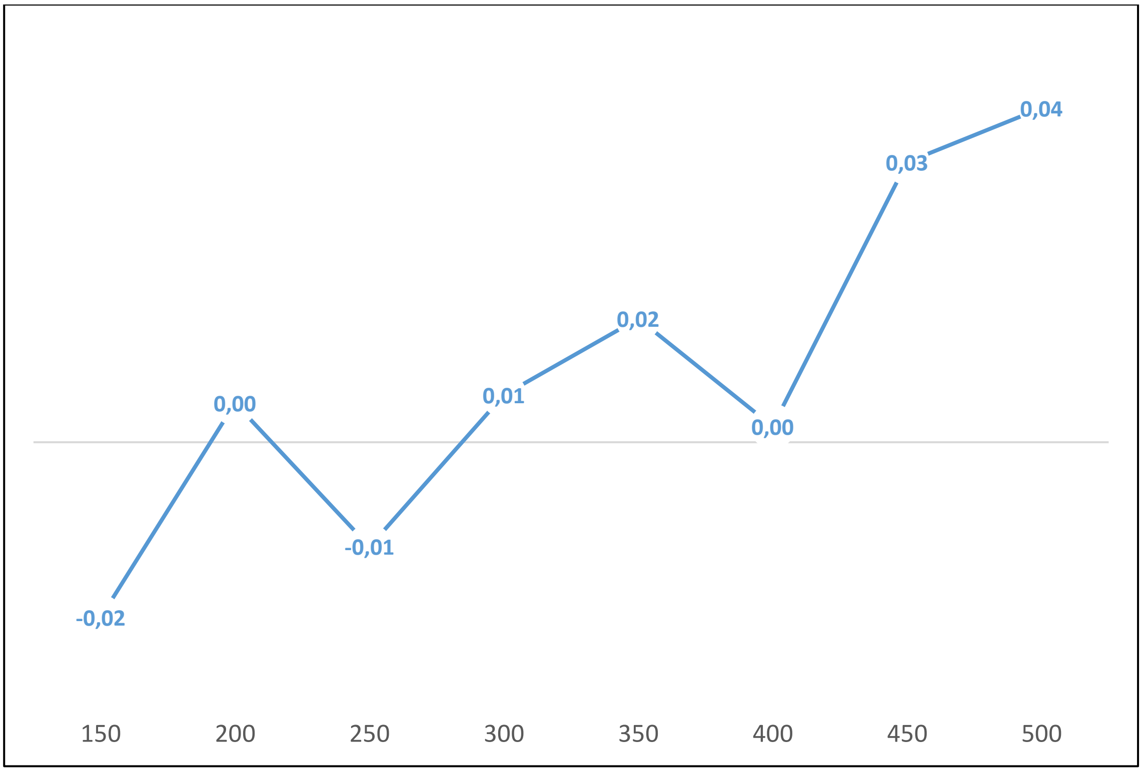


Figure 5. 1 – Cost Performance vs RAT Score

The 4th highest weighted Element is *Reserve Risk (including modifying factors)*. This Element refers to the degree of confidence in the reserve estimate relating to the resource deposit – the level of certainty regarding the assumptions relating to recoverable resources (Morley, 1999). Clearly this is one of the Elements which should be addressed as thoroughly as possible during the study, as a mistake regarding the size of the reserve could severely impact the viability of the project.

The 5th highest weighted Element is *Scope of Work Overview*. This refers to the level of definition up to which the scope of work during the project would have been defined and decomposed. Both the *Project Schedule* and the *Project Cost Estimate* depend on the level of definition of this Element. A comprehensive *Scope of Work Overview* forms the basis for managing the expectations of the end–user / client of the project.

The Element with the 6th highest weight is *Metallurgical Yield.* This refers to the expected recoverable mineral content as a ratio of the total mined ore. The economic evaluation of the project, which determines whether the project is economically viable, will be very sensitive to this parameter. If the Metallurgical Yield is incorrect, the assumption regarding sellable ore, as well as waste, will be wrong. This could lead to a double blow of lower–income due to lower ore production, and higher costs to dispose of waste. This Element can typically be better defined during the study by means of accurate and adequate sampling and testing to determine the yield as accurately as possible.

Resources Secured (Including land and mineral rights) is the 7th highest weighted Element. This Element refers to a certainty regarding the ownership of both the land upon which the mine is to be constructed and the right to mine it (LRC Centre, 2016). Misconceptions regarding this Element could impact the project significantly and lead to lengthy and expensive delays if not addressed during the study.

Geological Conditions (Geological model, structure, qualities) ranks 8th among the highest weighted elements. This includes the science of creating representations of portions of the Earth's crust based on geophysical and geological observations made on and below the Earth surface. It is a three–dimensional geological map complemented by a description of physical quantities. Since most of the geology is below the surface, sampling, and analysis, as well as model building during the study, are important for ensuring that the Geological Model is understood before implementation.

Project Scope Definition Ranks 9th on the list of highest weighted Elements. Project scope is the part of project planning that involves determining and documenting a list of specific project goals, deliverables, features, functions, tasks, deadlines, and ultimately, costs. In other words, it involves what needs to be achieved and the work that must be done to deliver a project (Gotto. J, 2013).

Operating Costs takes the number 10 spot among the Elements with the highest weights. This Element considers the degree to which consideration was given to the cost of utilities, supplies and materials, taxes, wages and benefits, transport costs and consumables during the study. (J K Tech SMI Technology transfer, 2012; Cost Mine, 2012). As operating costs will be incurred for the entire Life of Mine (LOM), any errors or omissions regarding this cost could impact the viability or profitability of the project.

In the preceding section, the various Categories and Sections of the RAT for Mining Projects were discussed and compared to each other. The highest weighted Elements were also discussed. In the next section, the results of the RAT validation process will be discussed.

5.2 Validating the weighted RAT instrument

In developing the previous PDRIs, the tool was not only developed, but also validated. This was done to determine a PDRI score, which if achieved, would indicate high confidence of project success. It must be kept in mind that the completeness of the project study is only one of the contributors to project success and can thus only account for some of the variances in project outcomes. However, in developing the previous four PDRIs, it was found that there is a score, which once achieved, indicated a significantly higher likelihood of project success. The way in which the tools are set up means that the PDRI score starts at 1000 when there is no definition to any of the elements, and then comes down, with an absolute minimum score of 70 indicating that all elements have achieved complete definition. However, very few, if any, projects will ever achieve this lower score. If too much time, effort and money are spent studying a project, the opportunity might be missed. In the resource sector, which includes mining, commodity prices go through cycles. It is, therefore, important to determine an optimum point between not doing enough work during the study, and doing too much, which may lead to missed opportunities.

A questionnaire was sent out to experienced professionals in the mining project field to validate and test the RAT. The same participants who completed the weighting check sheet were asked to complete the validation survey. Additional participants were also asked to participate in the validation portion of the study. The survey was made up of two sections. The first required participants to think of a specific project which had been completed recently, and with which the participant was familiar. The participant had to answer qualitative questions regarding the budget, schedule and change orders, and rate the investment performance, operating performance, and customer satisfaction of the specific project. This section of the questionnaire is depicted in Annexure M.

The second section of the questionnaire asked the participant to indicate the level of definition which the various elements had, at the time that the project study was completed (before detail design and implementation). To enable the participants to do so, they were given an unweighted RAT scorecard. The participants were asked to indicate the level of definition of each element (ranging from 1 to 5) at the time of project approval. The instructions given to participants is depicted in Figure 5.2.

Instructions for completion of Completed Project

Consider a recent project which you were involved in and are familiar with
Mark with an X, the Level of definition of each of the various elements, as it was at the start of the detail design phase of the project.

A	PROJECT STRATEGY	0	1	2	3	4	5
A.1	Project Justification				x		
A.2	Project Charter and Mandate					x	
A.3	Governance and control (internal approval process defined)				x		
A.5	Project Strategy		x				
A.6	Strategic fit of project in organisation		x				
A.7	Due diligence				x		

0 = Not applicable

1 = Complete definition

2 = Minor definition

3 = Some deficiencies

4 = Major deficiencies

5 = Incomplete or poor definition

Figure 5.2 – Instruction to participants

The intention was to correlate the relative project success with the RAT score, to determine a RAT score which would indicate a higher likelihood of project success. The previous PDRIs had determined this score to range between 200 and 250. This was known as the cut–off point.

The returned forms were scrutinised for completeness before being used. A total of 27 completed questionnaires were received, all of which were used. In the previous PDRIs, the number of projects used in the validation portion was 22, 23, 33 and 40. The projects which were submitted represented a total capital amount of R 258 billion (US $18 billion) and various countries. The largest project evaluated had a capital value of R 79 billion. Of the projects, 17 were Greenfield projects, while 10 were Brownfield.

The RAT scores of the projects as submitted were calculated, and the results were tabled along with the information regarding the outcomes of the projects. The RAT scores of the individual projects ranged from 105 to 613, with an average score of 319. Table 5.10 depicts the contributions of all the participants.

Table 5.10 – Information regarding projects received from participants

Identifier	RAT Score	Greenfield?	Planned duration	Actual duration
J1	105,70	1,00	40,00	42,00
J2	115,09	0,00	84,00	84,00
J3	147,00	0,00	29,00	28,00
J4	165,54	1,00	48,00	45,00
J5	188,53	1,00	44,00	48,00
J6	198,61	1,00	53,00	60,00
J7	203,13	0,00	18,00	25,00
J8	228,00	1,00	48,00	69,00
J9	230,89	1,00	22,00	22,00
J10	275,15	0,00	32,00	31,00
J11	285,09	1,00	24,00	26,00
J12	294,63	1,00	33,00	31,00
J13	297,99	1,00	18,00	22,00
J14	306,71	1,00	36,00	46,00
J15	321,47	1,00	48,00	60,00
J16	337,12	0,00	24,00	42,00
J17	347,60	1,00	26,00	32,00
J18	356,39	1,00	36,00	48,00
J20	381,00	1,00	48,00	45,00
J21	401,62	1,00	38,00	65,00
J22	426,11	0,00	42,00	65,00
J23	440,22	0,00	10,00	13,00
J24	487,64	0,00	123,00	132,00
J25	493,54	1,00	42,00	60,00
J26	583,71	0,00		
J27	613,99	0,00	10,00	10,00

Identifier	RAT Score	Original cost (Millions)	Actual cost (Millions)	Change orders	Value of CO (Millions)
J1	105,7	R79 200,00	R77 760,00		R1 440,00
J2	115,09	R9 000,00	R9 000,00	1500	R0,00
J3	147	R13 000,00	R12 400,00	40	R450,00
J4	165,54	R8 500,00	R8 500,00		R0,00
J5	188,53	R3 340,00	R3 290,00	46	R385,00
J6	198,61	R17 480,00	R19 370,00	200	R2 200,00
J7	203,13	R1 660,00	R1 610,00	4	R34,00
J8	228	R5 461,70	R5 034,55	145	R1 057,99
J9	230,89	R958,00	R924,00	48	R101,00
J10	275,15	R83,00	R82,90	4	R1,60
J11	285,09	R5 850,00	R5 850,00	100	R650,00
J12	294,63	R6 734,56	R7 179,36	126	R444,80
J13	297,99	R3 200,00	R3 600,00	150	R400,00
J14	306,71	R0,00	R0,00		R0,00
J15	321,47	R7 000,00	R7 500,00	50	R800,00
J16	337,12	R1 710,00	R1 950,00	1070	R249,00
J17	347,6	R4 500,00	R4 300,00		R0,00
J18	356,39	R1 000,00	R850,00	1000	–R235,00
J19	365,88	R1 500,00	R1 500,00	200	R80,00
J20	381	R9 000,00	R8 500,00		R0,00
J21	401,62	R16 016,00	R16 702,00	1386	R686,00
J22	426,11	R921,60	R1 512,00		R0,00
J23	440,22	R4 200,00	R3 800,00	1000	R500,00
J24	487,64	R4 200,00	R2 700,00	339	R1 740,00
J25	493,54	R50 400,00	R86 400,00	1000	R28 800,00
J26	583,71	R2 966,00	R4 059,00		R0,00
J27	613,99	R200,00	R194,00	5	R8,00

The intention during this phase of the research was to prove the second proposition:

Proposition 2 – "*The RAT score indicates the current level of Scope Definition and corresponds to project performance. Mining projects with low RAT scores outperform projects with high RAT scores.*"

As highlighted in section 3.1, in developing the previous PDRIs, various means were used to assess the relative success of a project and test for correlation with the PDRI score. While developing the PDRI for Infrastructure Projects, Bingham (2010:85), used cost overrun, schedule overrun, and the cost impact of change orders to measure success. These same variables were used to determine a cut–off point for the RAT for Mining Projects. In the previous PDRIs, the cut–off points were always rounded to the nearest 50, and it was decided that the same approach should be followed. The typical cut–off points would be 150, 200 and 250. Three of the previous four PDRIs had used 200 as the cut–off point.

Bingham (2010:86) used the following formulae to calculate values for schedule–, cost– and change information performance:

Schedule Performance = (Actual Project Duration – Planned Project Duration) / Planned Project Duration

Cost Performance = (Actual Project Cost – Budgeted Project Cost) / Budgeted Project Cost

Change Performance = Total cost of change orders / Actual Project Cost

To determine the Schedule Performance of the submitted projects, participants were asked to submit the planned project duration as well as the actual project duration of the projects. Not all the participants supplied information regarding cost, schedule and change orders. Where a specific participant did not provide information regarding one or more of the performance indexes, the contribution of that specific participant was excluded from the calculation of that specific performance index. As a result, Table 5.11 depicts inputs of 26 projects, as one of the participants did not provide information regarding the Schedule Performance. The results of this calculation, along with the RAT score of the individual projects, can be seen in Table 5.11.

Table 5.11 – RAT scores and Schedule Performance of submitted projects

RAT Score	Schedule Performance
105,7	0,05
115,1	0,00
147,0	–0,03
165,5	–0,06
188,5	0,09
198,6	0,13
203,1	0,39
228,0	0,44
230,9	0,00
275,1	–0,03
285,1	0,08
294,6	–0,06
298,0	0,22
306,7	0,28
321,5	0,25
337,1	0,75
347,6	0,23
356,4	0,33
370,8	0,00
381,0	–0,06
401,6	0,71
426,1	0,55
452,2	0,30
487,6	0,07
493,5	0,43
614,0	0,00

The Schedule Performance ranges between –0.06 and 0.75, with an average of 0.19. To determine an appropriate cut–off point, the average Schedule Performance was compared for projects with a RAT score below 150 and those above. The same was done for projects with a RAT score of 200, 250, 300, 350, 400, 450 and 500. The results are depicted in Table 5.12 and Figure 5.3.

Table 5.12 – Average Schedule Performance vs cut–off points

RAT Score <	Average Schedule Performance
150	0,01
200	0,03
250	0,11
300	0,09
350	0,16
400	0,15
450	0,19
500	0,20

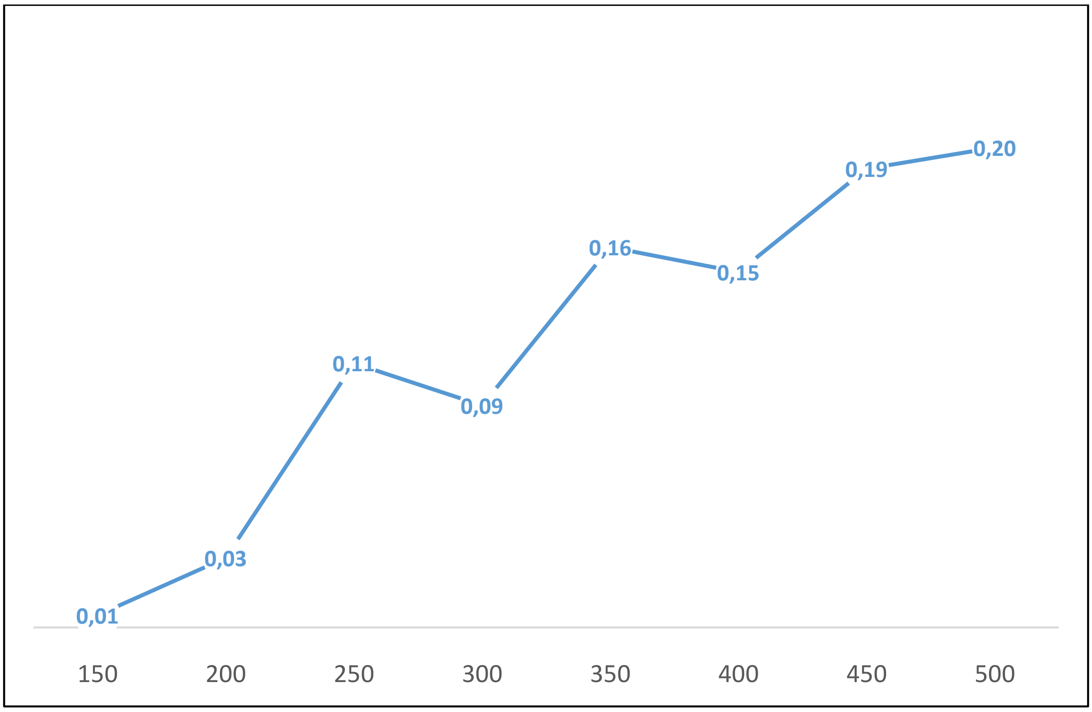


Figure 5.3 – Average Schedule Performance vs cut–off points

Three projects had a RAT score below 150, and the average Schedule Performance rating was –.01. Six projects scored below 200, with an average Schedule Performance rating of 0.03. Nine projects had a RAT score below 250, with an average Schedule Performance rating of 0.11. 13 projects had a RAT score below 300, with an average Schedule Performance rating of 0.09. 17 projects had a RAT score below 350, with an average Schedule Performance rating of 0.16. 20 projects had a RAT score lower than 400, with an average performance rating of 0.15. Based on this, 200 would be an appropriate cut–off point for the RAT for Mining Projects.

On average, those projects with a RAT score below 200 took 3% longer to complete than anticipated, while those with a RAT score above 200 took 24% longer to complete. The average Schedule Performance for projects with a RAT score below 200, and those above 200 are shown in Table 5.13 and Figure 5.4

Table 5.13 – Average Schedule Performance using 200 as a cut–off point

RAT Score	Schedule Performance	Average Schedule Performance
105,7	0,05	
115,1	0,00	
147,0	–0,03	
165,5	–0,06	
188,5	0,09	
198,6	0,13	**0,03**
Cut–off = 200		
203,1	0,39	
228,0	0,44	
230,9	0,00	
275,1	–0,03	
285,1	0,08	
294,6	–0,06	
298,0	0,22	
306,7	0,28	
321,5	0,25	
337,1	0,75	
347,6	0,23	
356,4	0,33	
370,8	0,00	
381,0	–0,06	
401,6	0,71	
426,1	0,55	
452,2	0,30	
487,6	0,07	
493,5	0,43	
614,0	0,00	**0,24**

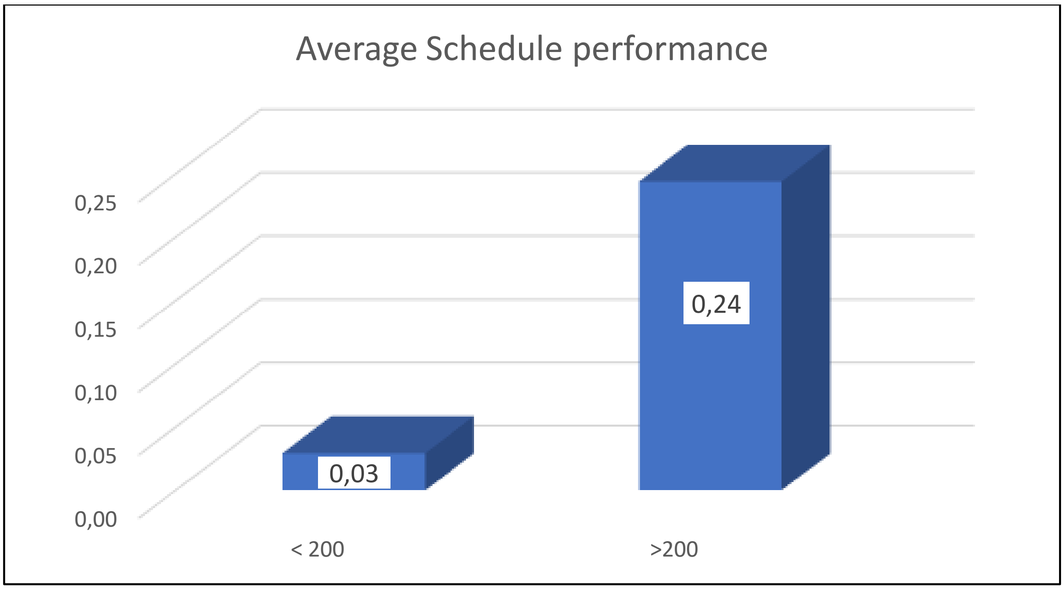


Figure 5.4 – Average Schedule Performance using 200 as cut–off

As with Schedule Performance, participants were asked to provide information regarding costs and impact of change orders. This was used to determine the Cost Performance and Change Performance of the individual projects.

Table 5.14 depicts the Cost Performance of the submitted projects, along with their RAT scores. A visual inspection of the data in Table 5.14 clearly showed a variability in the Cost Performance of projects. The correlation between RAT scores and Cost Performance was not very clear just from examining Table 5.14. However, as illustrated in Table 5.15 and Figure 5.5, where the average Cost Performance is depicted against the various potential cut–off points (150, 200, 250, 300, 350, 400, 450, 500), projects with a lower RAT score generally have better Cost Performance indicators.

Table 5.14 – Cost Performance vs RAT score

RAT Score	Cost Performance
105,70	–0,02
115,09	0,00
147,00	–0,05
165,54	0,00
188,53	–0,01
198,61	0,11
203,13	–0,03
228,00	–0,08
230,89	–0,04
275,15	0,00
285,09	0,00
294,63	0,07
297,99	0,13
321,47	0,07
337,12	0,14
347,60	–0,04
356,39	–0,15
370,76	0,00
381,00	–0,06
401,62	0,04
426,11	0,64
452,19	–0,10
487,64	–0,36
493,54	0,71
583,71	0,37
613,99	–0,03

Table 5.15 – Average Cost Performance vs cut–off points

RAT Score	Average
150	**–0,02**
200	**0,00**
250	**–0,01**
300	**0,01**
350	**0,02**
400	**0,00**
450	**0,03**
500	**0,04**

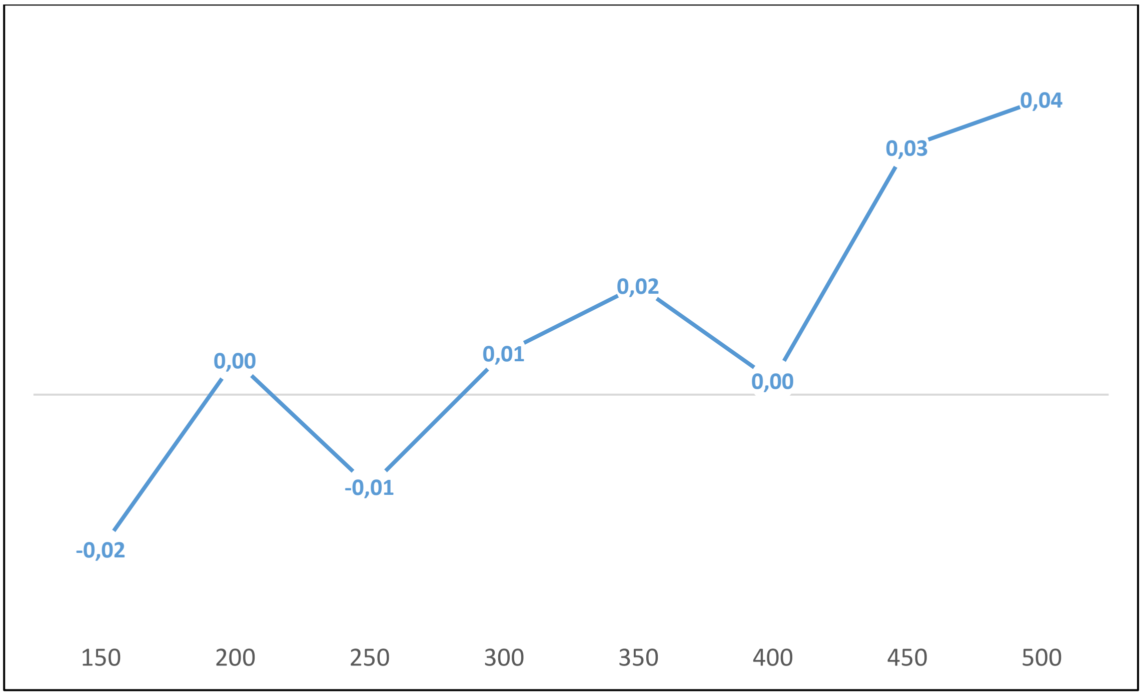


Figure 5.5 – Cost Performance vs RAT Score

From Figure 5.5, several potential cut–off values could be used, with both 200 and 400 having an average Cost Performance of 0,00. The average Cost Performance of projects with a RAT score lower than 200 is illustrated in Table 5.16 and Figure 5.6, while the average Cost Performance of projects with a RAT score lower than 400 is illustrated in Table 5.17 and Figure 5.7.

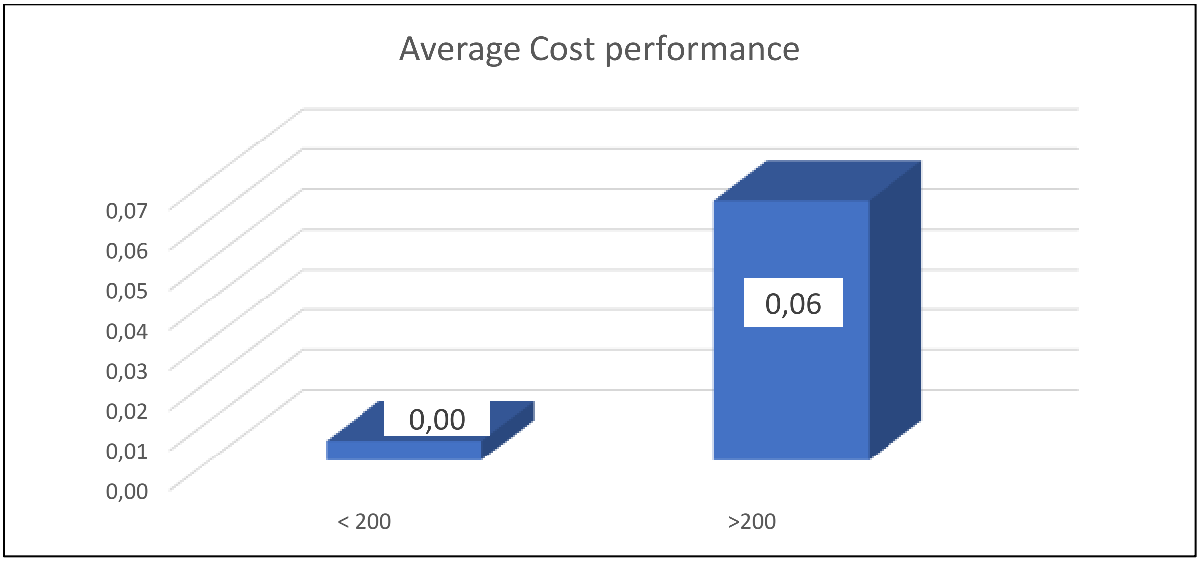


Figure 5.6 – Average Cost Performance using 200 as cut–off

Table 5.16– Average Cost Performance using 200 as a cut–off point

RAT Score	Cost Performance	Average Schedule Performance
105,7	–0,02	
115,1	0,00	
147,0	–0,05	
165,5	0,00	
188,5	–0,01	
198,6	0,11	**0,00**
Cut–off = 200		
203,1	–0,03	
228,0	–0,08	
230,9	–0,04	
275,1	0,00	
285,1	0,00	
294,6	0,07	
298,0	0,13	
321,5	0,07	
337,1	0,14	
347,6	–0,04	
356,4	–0,15	
370,8	0,00	
381,0	–0,06	
401,6	0,04	
426,1	0,64	
452,2	–0,10	
487,6	–0,36	
493,5	0,71	
583,7	0,37	
614,0	–0,03	**0,06**

Table 5.17– Average Cost Performance using 400 as a cut–off point

RAT Score	Cost Performance	Average Schedule Performance
105,7	–0,02	
115,1	0,00	
147,0	–0,05	
165,5	0,00	
188,5	–0,01	
198,6	0,11	
203,1	–0,03	
228,0	–0,08	
230,9	–0,04	
275,1	0,00	
285,1	0,00	
294,6	0,07	
298,0	0,13	
321,5	0,07	
337,1	0,14	
347,6	–0,04	
356,4	–0,15	
370,8	0,00	
381,0	–0,06	
Cut–off = 400		**0,00**
401,6	0,04	
426,1	0,64	
452,2	–0,10	
487,6	–0,36	
493,5	0,71	
583,7	0,37	
614,0	–0,03	**0,18**

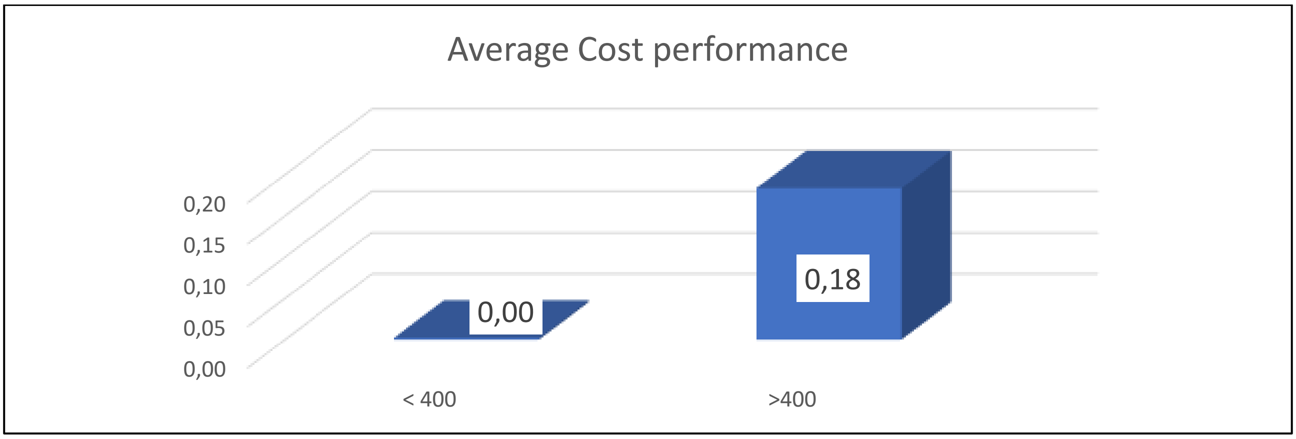


Figure 5.7 – Average Cost Performance using 400 as cut–off

Both 200 and 400 could be used as a potential cut–off point, although projects with a RAT score higher than 400 have a more significant cost overrun (18%) than those with a RAT score higher than 200 (6%).

Table 5.18 depicts the Change Performance of the submitted projects along with their RAT scores.

Table 5.18 – RAT score vs Change Performance

RAT Score	Change Performance
105,70	0,02
147,00	0,04
188,53	0,12
198,61	0,11
203,13	0,02
228,00	0,21
230,89	0,11
275,15	0,02
285,09	0,11
294,63	0,06
297,99	0,11
321,47	0,11
337,12	0,13
356,39	0,28
370,76	0,05
401,62	0,04
452,19	0,13
487,64	0,64
493,54	0,33

The Change Performance ranges between 0.02 and 0.64, with an average of 0.14. To determine an appropriate cut–off point, the average Change Performance was compared for projects with a RAT score below 150 and those above. The same was done for projects with a RAT score of 200, 250, 300, 350, 400, 450 and 500. The results are depicted in Table 5.19 and Figure 5.8.

Table 5.19– Average Change Performance vs Cut–off points

RAT <	Average =
150	0,03
200	0,07
250	0,09
300	0,08
350	0,09
400	0,10
450	0,10
500	0,14

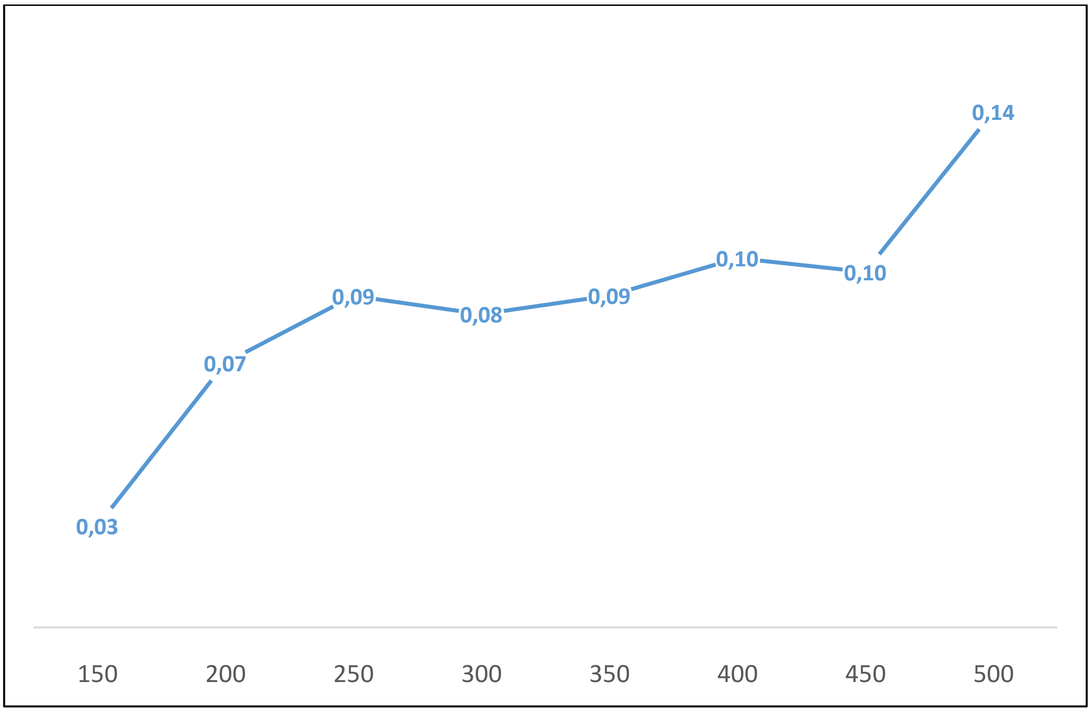


Figure 5.8 – Change Performance vs RAT score

Two projects had a RAT score of below 150, with an average Change Performance rating of 0.03, while four projects scored below 200, with an average Change Performance rating of 0.07. Seven projects had a RAT score below 250, with an average Change Performance rating of 0.09. Based on this, 150 or 200 would be an appropriate cut–off point for the RAT for Mining Projects. This is further discussed later in this chapter.

On average, those projects with a RAT score below 150 experienced a cost impact of 3% due to change orders, while those with a RAT score above 150 experienced a cost impact of 16% due to change orders. The average Change Performance for projects with a RAT score below 150, and those above 150 are shown in Table 5.20 and Figure 5.9. The average Change Performance for projects with a RAT score below 200, and those above 200 are shown in Table 5.21 and Figure 5.10.

Table 5.20 – Change Performance using 150 as a cut–off

	Change Performance	Average Change Performance
105,70	**0,02**	
147,00	**0,04**	**0,03**
188,53	0,12	
198,61	0,11	
203,13	0,02	
228,00	0,21	
230,89	0,11	
275,15	0,02	
285,09	0,11	
294,63	0,06	
297,99	0,11	
321,47	0,11	
337,12	0,13	
356,39	0,28	
370,76	0,05	
401,62	0,04	
452,19	0,13	
487,64	0,64	
493,54	0,33	0,15

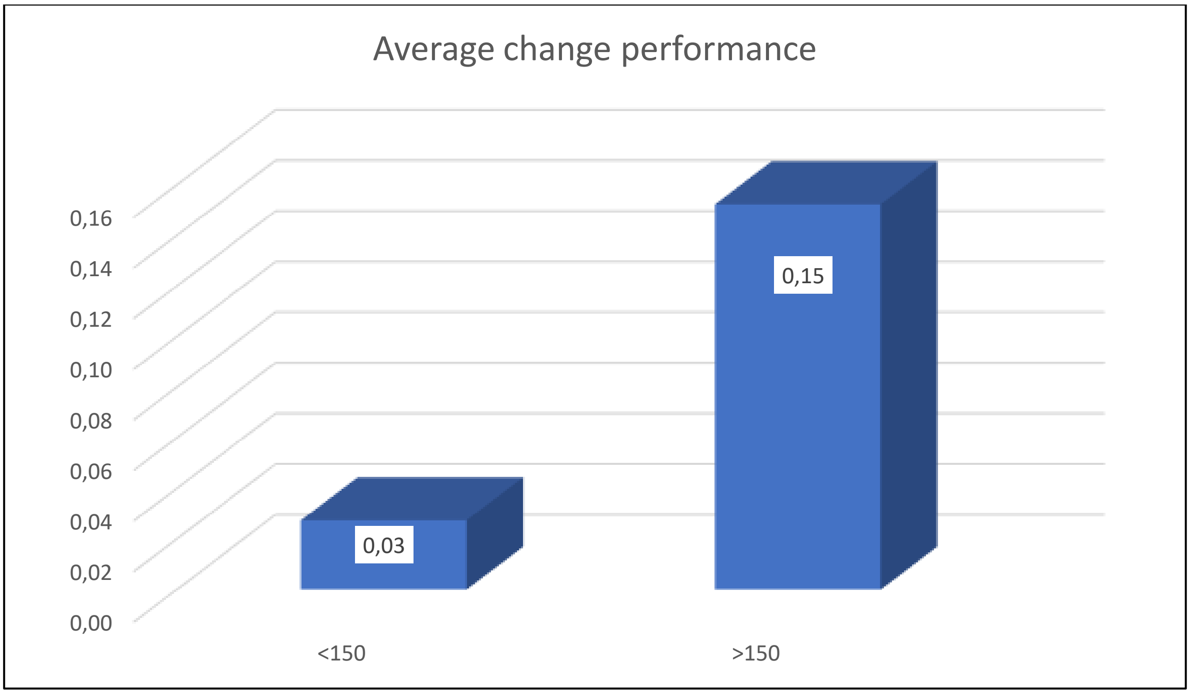


Figure 5.9 – Change Performance using 150 as cut–off

Table 5.21 – Change Performance using 200 as a cut–off

RAT Score	Change Performance	Average Change Performance
105,70	**0,02**	
147,00	**0,04**	
188,53	**0,12**	
198,61	**0,11**	**0,07**
203,13	0,02	
228,00	0,21	
230,89	0,11	
275,15	0,02	
285,09	0,11	
294,63	0,06	
297,99	0,11	
321,47	0,11	
337,12	0,13	
356,39	0,28	
370,76	0,05	
401,62	0,04	
452,19	0,13	
487,64	0,64	
493,54	0,33	0,16

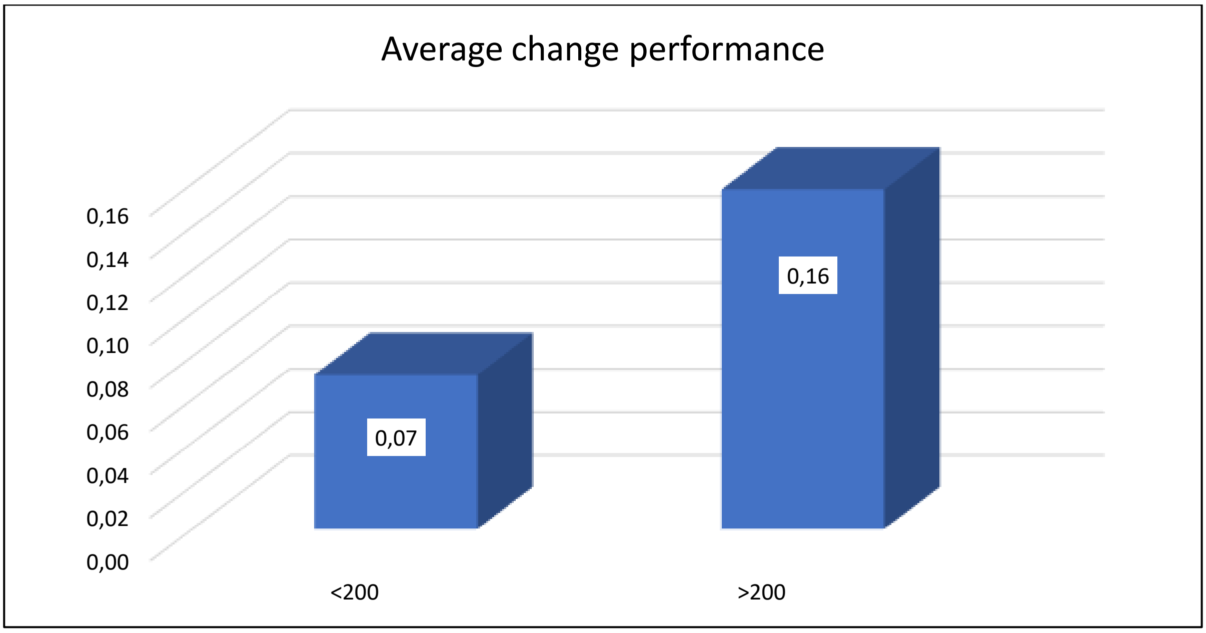


Figure 5.10 – Change Performance using 200 as cut–off

After an initial analysis of the three performance criteria (Schedule– Cost– and Change Performance), where the performance of projects above and below specific cut–off scores was compared (See the preceding portion of section 5.2 above), cut–off points were suggested. The cut–off points were based on the difference in performance between projects with a RAT score below and above the suggested cut–off score. The intention was to identify the cut–off score where projects with a RAT score lower than the suggested cut–off, performed significantly better than those projects with a RAT score above the suggested cut–off score.

The following cut–off points were suggested:
Schedule Performance – 200
Cost Performance – 200 or 400
Change Performance – 150 or 200

To determine if the difference in the indicators between the two groups (RAT scores above and below cut–off point) was statistically significant, statistical analysis was performed. The outcome of this analysis is shown in Table 5.22.

Table 5.22 – Comparison of RAT scores above and below 200 – Schedule Performance

T–test for equality of means				
t	**df**	**T critical 2 tailed**	**Mean differences**	**Variance differences**
–3,389	24,000	2,064	–0,215	–0,056

Table 5.22 compares the two groups (below and above 200 RAT scores) in terms of average Schedule Performance. A t–test was performed, which revealed that the variances could not be assumed to be equal. The t Stat of –3.389 falls outside of the range between –T critical 2 tailed (–2,064) and T critical 2 tailed (2,064), which means that there is a statistically significant difference between the Schedule Performance of those projects with a RAT score below 200, and those with a RAT score above 200.

The results of a t–test calculation for Cost Performance, comparing the average Cost Performance of projects with a RAT score below 200 with those above 200, are shown in Table 5.23. Similarly, the results of a t–test on projects with a RAT score above and below 400 are shown in Table 5.24.

Table 5.23 – Comparison of RAT scores above and below 200 – Cost Performance

T–test for equality of means					
t	**df**	**T critical 2 tailed**	**Mean differences**	**Variance differences**	**P–Value**
–0,994	23,000	2,069	–0,060	–0,060	0,330366

Table 5.24 – Comparison of RAT scores above and below 400 – Cost Performance

T–test for equality of means					
t	**df**	**T critical 2 tailed**	**Mean differences**	**Variance differences**	**P–Value**
–1,193	6,000	2,447	–0,181	–0,155	0,277902

In both cases, the t–Stat falls between –T critical 2 tailed and T critical 2 tailed, which means that there is not a statistically significant difference between the Cost

Performance of those projects with a RAT score below 200 and 400, and those with a RAT score above 200 and 400 respectively. The P values for both tables above are bigger than the alpha value (0.05), which also means that there is not a statistically significant difference between the Cost Performance of those projects with a RAT score below 200 and 400, and those with a RAT score above 200 and 400 respectively. Based on the cut–off points in previous PDRIs, as well as those of the other indicators in this study, 200 is suggested as the appropriate cut–off.

The results of a t–test calculation for Change Performance, comparing the average Change Performance of projects with a RAT score below 200 with those above 200, are shown in Table 5.25. Similarly, the results of a t–test on projects with a RAT score above and below 150 are shown in Table 5.26

Table 5.25 – Comparison of RAT scores above and below 200 – Change Performance

T–test for equality of means					
t	df	T critical 2 tailed	Mean differences	Variance differences	P–Value
–1,751	16,000	2,120	–0,086	–0,024	0,09901

Table 5.26 – Comparison of RAT scores above and below 150 – Change Performance

T–test for equality of means					
t	df	T critical 2 tailed	Mean differences	Variance differences	P–Value
–3,292	17,000	2,110	–0,125	–0,023	0,004303

When 150 is evaluated as the cut–off, the t–Stat falls outside of the range between –T critical 2 tailed and T critical 2 tailed, which means that there is a statistically significant difference between the Change Performance of projects with a RAT score below 150, and those with a RAT score above 150. The P–value in Table 5.26 is smaller than the alpha value (0.05), which also means that there is a statistically significant difference between the Change Performance of those projects with a RAT score below 150, and those with a RAT score of above 150.

When 200 is evaluated as the cut–off, the t–Stat falls within of the range between –T critical 2 tailed and T critical 2 tailed, which means that there is not a statistically significant difference between the Change Performance of projects with a RAT score below 200, and those with a RAT score above 200. The P–value in Table 5.25 is bigger than the alpha value (0.05), which also means that there is not a statistically significant difference between the Change Performance of those projects with a RAT score below 200, and those with a RAT score above 200. It would, therefore, appear that 150 is the appropriate cut–off RAT score for Change Performance.

Regression analysis of the performance measures (schedule, cost and change orders) was conducted (using Microsoft Excel) versus the RAT score, and an individual graph constructed for each of these. This was done by plotting the RAT score on the X–axis and the corresponding performance measure against the Y–axis. The resulting scatterplot graphs are shown in Figure 5.11, Figure 5.12, and Figure 5.13. The accompanying data is depicted in Table 5.27, Table 5.28, and Table 5.29. A bivariate linear regression was conducted to fit a trendline through the scatterplot. The resulting equation in the form of $Y = b_1X + b_0$ was obtained, as was the r value and the R^2 value for each of the performance measures.

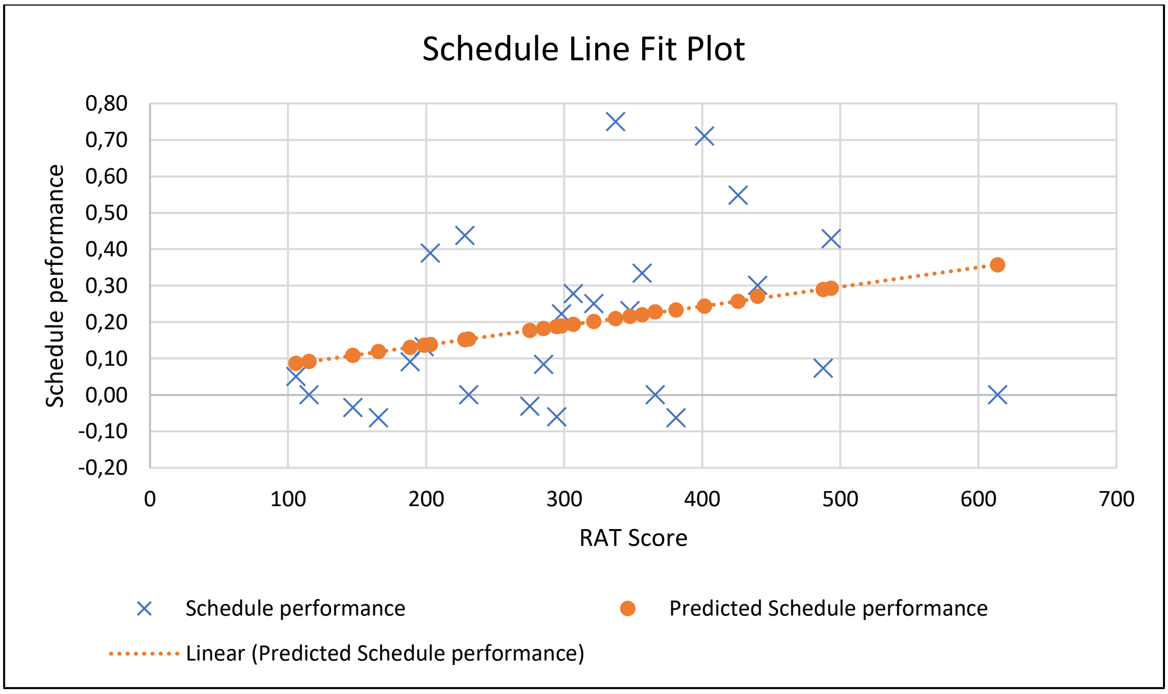


Figure 5.11 – Regression line and scatterplot for Schedule Performance

Figure 5.11 depicts the resulting scatterplot and regression line (using Microsoft Excel) for Schedule Performance. The scatterplot shows an upward trend for projects which took longer to complete than initially anticipated.

Table 5.27 – Regression Statistics and Coefficients for Schedule Performance

Regression Statistics	
Multiple R	0,280728507
R Square	0,078808495
Adjusted R Square	0,040425515
Standard Error	0,232485831
Observations	26

	Coefficients
Intercept	0,03046078
RAT Score	0,000530831

The equation from the regression is Y= 0.00053X + 0.0405, which suggests that a RAT score increase of 1 point would increase the project's total duration by 0.053% over what was initially planned. This would mean that a RAT score increase of 100 would result in a 5.3% increase in duration. The average duration of the projects which were submitted for this study was 38.5 months. A 5.3% increase equates to an increase of 2.04 months. Thus, the average project in this study could have been shortened by more than two months for every 100 RAT point reduction.

The R^2 value of 0.079 indicates that 7.9% of the variability in Schedule Performance can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning. As mentioned before, the level of maturity of a project study is not the only determinant of project success, and this could explain the relatively low value of R^2. This is further addressed later in this chapter.

Figure 5.12 depicts the resulting scatterplot and regression line for Cost Performance.

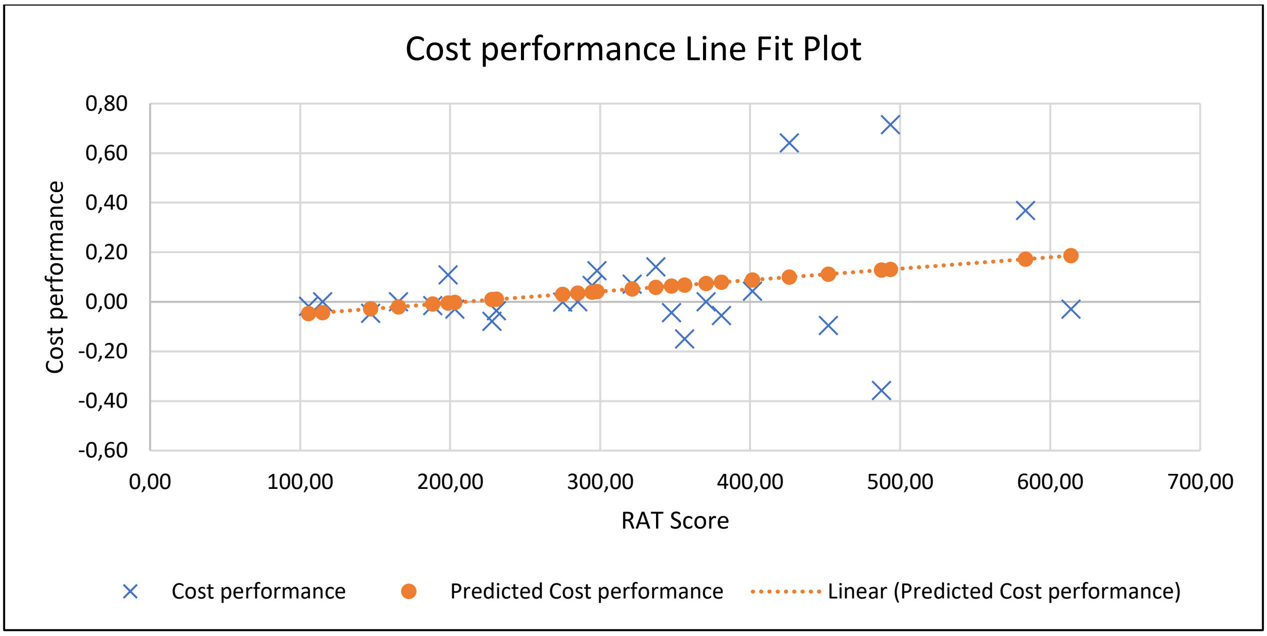


Figure 5.12 – Regression line and scatterplot for Cost Performance

Table 5.28 – Regression statistics and Coefficients for Cost Performance

Regression Statistics	
Multiple R	0,284028048
R Square	0,080671932
Adjusted R Square	0,042366596
Standard Error	0,216504932
Observations	26

	Coefficients
Intercept	–0,09623028
RAT Score	0,000460068

The equation from the regression is Y= 0.00046X – 0.096, which suggests that a RAT score decrease by 1 point would decrease the project's total cost by 0.046% over what was initially planned. This would mean that a RAT score decrease of 100 would result in a 4.6% decrease in project cost. This is discussed further later in this chapter.

The R^2 value of 0.0806 indicates that 8.06% of the variability in Cost Performance can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning. As mentioned before, the level of maturity of a project study is not the only determinant of project success, and this explains the relatively low value of R^2. This is further discussed in Chapter 5.

Figure 5.13 depicts the resulting scatterplot and regression line for Change Performance. The scatterplot shows an upward trend for projects with higher change order costs.

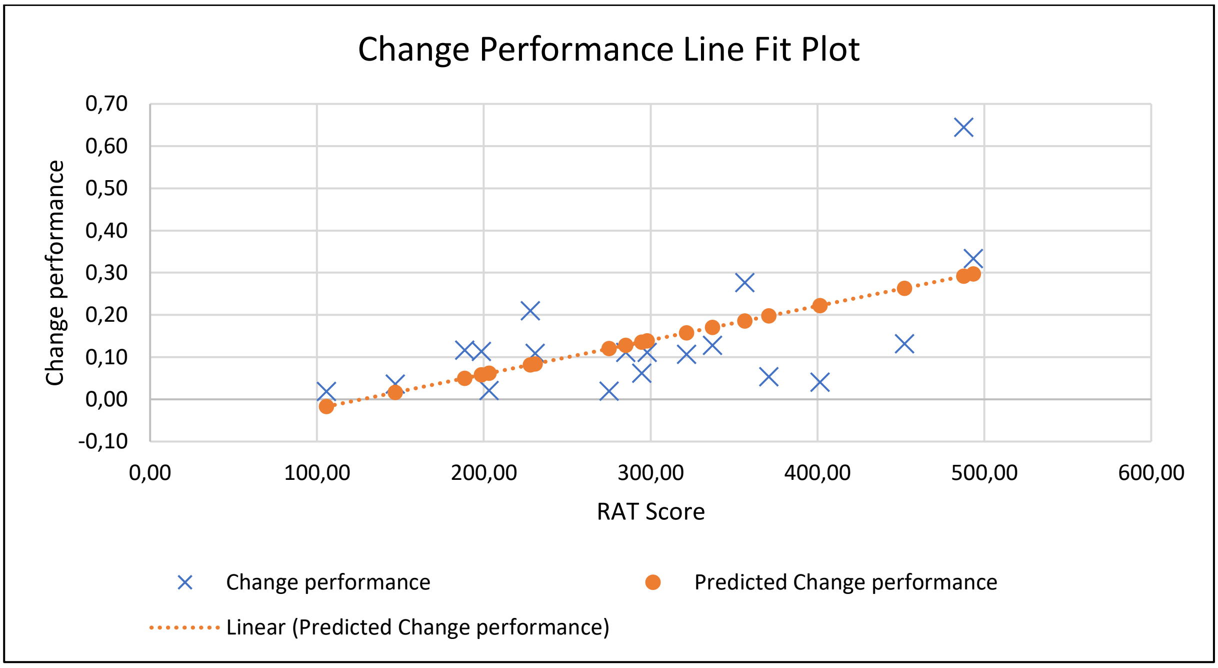


Figure 5.13 – Regression line and scatterplot for Change Performance

Table 5.29 – Regression statistics and Coefficients for Change Performance

Regression Statistics	
Multiple R	0,602170516
R Square	0,36260933
Adjusted R Square	0,325115761
Standard Error	0,122180066
Observations	19

	Coefficients
Intercept	–0,102692017
RAT Score	0,000809659

The equation from the regression is Y= 0.00081X – 0.1027, which suggests that a RAT score increase of 1 point would impact the project's total cost due to change orders by 0.08%. This would mean that a RAT score increase of 100 would result in an 8% impact on project cost due to change orders. The average cost of projects in this study was R11,3 billion, which means that a 100–point decrease in RAT score would have resulted in a reduction of R906.4 million due to change orders.

The R^2 value of 0.3626 indicates that 36.26% of the variability in Change Performance can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning. As mentioned before, the level of maturity of a project study is not the only determinant of project success, and this explains the relatively low value of R^2. This is further addressed later in this chapter.

Apart from the quantitative measures regarding the effect of the RAT score on cost and schedule, and the effect of change orders on the project, participants in the validation study were also asked to rate three other measures. These revolved around the actual performance vs the expected performance of the delivered project (*Performance Score*); the actual *Operating Performance* (including capacity and availability) vs the expected performance; and the overall success of the project (*Customer Satisfaction*). Participants were asked to rate these three measures on a scale of 1 to 5, with one representing *falling far short* and five *far exceeding expectations*. The questions formed part of the validation portion of the survey and can be seen in Figure 5.14.

Investment information

Using a scale of 1 – 5 (1 being fallen far short and 5 being far exceeded all expectations) how has the actual performance of the delivered project measured up to the expected performance? (Mark with an X)

1	
2	
3	
4	
5	

Operating performance

Using a scale of 1 – 5 (1 being fallen far short and 5 being far exceeded all expectations) – Since being placed in service, has the operational performance (including capacity and availability) met the expectations?

1	
2	
3	
4	
5	

Customer satisfaction

Using a scale of 1 – 5 (1 being very unsuccessful and 5 being very successful) – Reflecting on the overall project, rate the success of the project.

1	
2	
3	
4	
5	

Figure 5.14 – Questions regarding the perceived performance of the completed project

The results of this feedback are shown in Table 5.30.

Table 5.30 – RAT scores compared to Performance–, Operating– and Customer Scores

RAT Score	Performance Score	Operating Score	Customer Score
105,70	4	2	3
115,09	5	5	5
147,00	5	4	5
165,54	5	5	4
188,53	5	5	4
198,61	4	4	
203,13	5	4	4
228,00	4	4	5
230,89	4	3	3
275,15	4	4	4
285,09	4	3	3
294,63	4	4	3
297,99	4	4	4
306,71	3	3	3
321,47	3	3	3
337,12	4	4	4
347,60	4	3	4
356,39	5	4	3
370,76	4	4	4
381,00	5	5	5
401,62	4	2	3
426,11	1	5	3
452,19	3	3	4
487,64	4	3	5
493,54	3	4	3
583,71	2	3	3
613,99	3	4	4

To determine an appropriate cut–off point using these three scores, the data from the survey were tabulated as depicted in Table 5.31.

Table 5.31 – Data from survey converted to percentage and cumulative percentage

	Number					
RAT Score	**1**	**2**	**3**	**4**	**5**	**Sum**
Lower than 150	0	1	1	2	5	9
Higher than 150	1	2	23	33	12	71
RAT Score	**1**	**2**	**3**	**4**	**5**	**Sum**
Lower that 200	0	1	1	6	9	17
Higher than 200	1	2	23	29	8	63
RAT Score	**1**	**2**	**3**	**4**	**5**	**Sum**
Lower than 250	0	1	3	11	11	26
Higher than 250	1	2	21	24	6	54
RAT Score	**1**	**2**	**3**	**4**	**5**	**Sum**
Lower than 300	0	1	6	20	11	38
Higher than 300	1	2	18	15	6	42
RAT Score	**1**	**2**	**3**	**4**	**5**	**Sum**
Lower than 350	0	1	13	25	11	50
Higher than 350	1	2	11	10	6	30

	Percentage					Cumulative Percentage				
RAT Score	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Lower than 150	0%	11%	11%	22%	56%	0%	11%	22%	44%	100%
Higher than 150	1%	3%	32%	46%	17%	1%	4%	37%	83%	100%
RAT Score	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Lower that 200	0%	6%	6%	35%	53%	0%	6%	12%	47%	100%
Higher than 200	2%	3%	37%	46%	13%	2%	5%	41%	87%	100%
RAT Score	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Lower than 250	0%	4%	12%	42%	42%	0%	4%	15%	58%	100%
Higher than 250	2%	4%	39%	44%	11%	2%	6%	44%	89%	100%
RAT Score	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Lower than 300	0%	3%	16%	53%	29%	0%	3%	18%	71%	100%
Higher than 300	2%	5%	43%	36%	14%	2%	7%	50%	86%	100%
RAT Score	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Lower than 350	0%	2%	26%	50%	22%	0%	2%	28%	78%	100%
Higher than 350	3%	7%	37%	33%	20%	3%	10%	47%	80%	100%

The data were stratified according to the RAT score of the project. Cut–off points of 150, 200, 250, 300 and 350 were evaluated to determine if there was any significance in using these values as cut–off points. To visually represent the effect of the RAT score on the combined Performance–, Operating–, and Customer Scores, the number of times which participants had rated the performance of the completed projects as 1, 2, 3, 4 and 5 was totalled. This was done for each of the potential cut–off points. The results of this calculation were converted to a percentage by calculating the proportion of the responses assigned to each of the measures of success (1, 2, 3, 4 and 5). The following formula was used (Using rating of 5 and 150 as a cut–off as an example):

*Percentage = (Number of times project was rated as 5 / Sum of all ratings of projects with RAT score lower than 150) * 100*

In this example, the calculation equated to:
*56% = (5 / 9) * 100*

The outcome of this calculation is shown in Table 5.31 in the columns labelled “Percentage”. These columns were converted to cumulative percentages for all projects below and above the suggested cut–off points. The graphical representations of the cumulative percentages are depicted in Figure 5.15, Figure 5.16, Figure 5.17, Figure 5.18, and Figure 5.19.

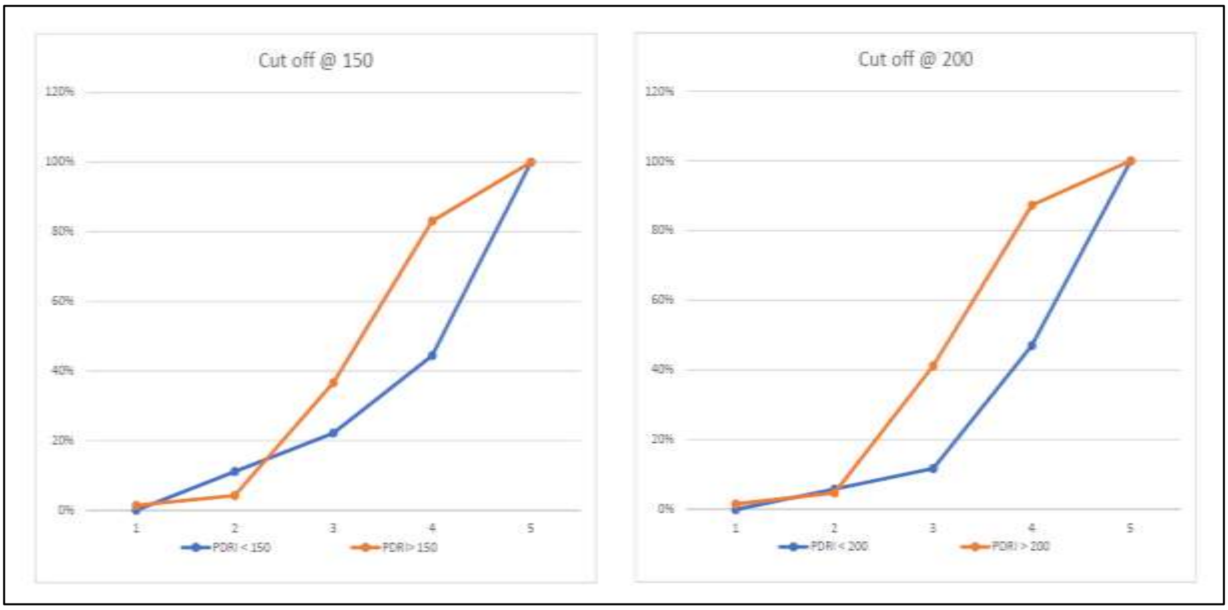
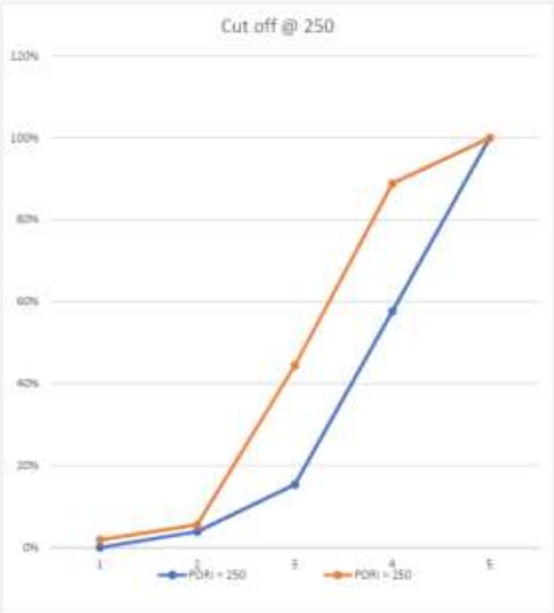


Figure 5.15 – Completed project performance vs Cut–offs at 150

Figure 5.16 – Completed project performance vs Cut–offs at 200



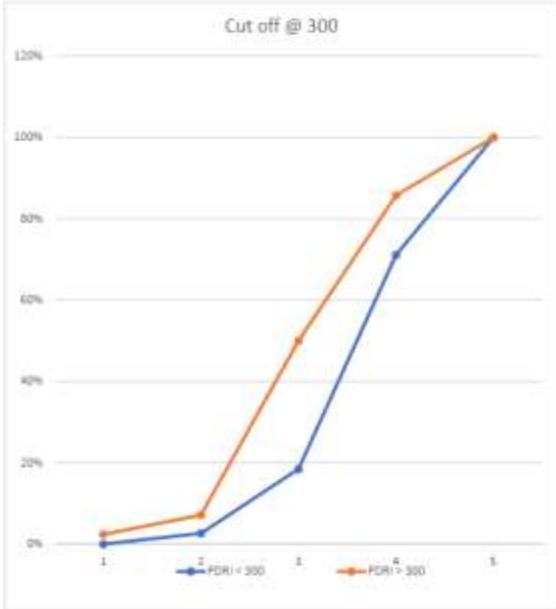


Figure 5.17 – Completed project performance vs Cut–offs at 250

Figure 5.18 – Completed project performance vs Cut–offs at 300

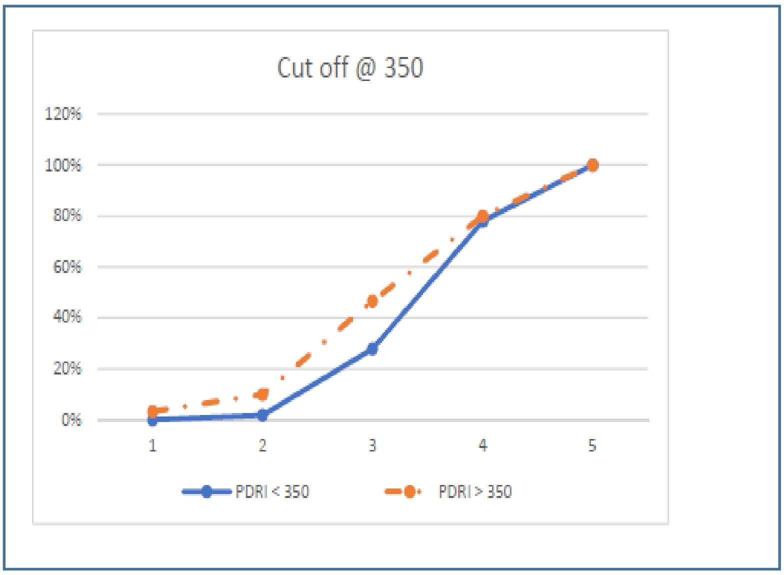


Figure 5.19 – Completed project performance vs Cut–off at 350

Projects with a RAT lower than 150, 200, 250 and 300 are trending more to the right of the graph Based on the criteria of Operating–, Performance– and Customer Scores, these projects were deemed to be more successful on average than the average of the projects with RATs above the cut–off points. By examining the plots when 200, 250, 300 and 350 are used as a potential cut–offs, it is clear that the two lines depicting cumulative percentage, get closer to one another, as the cut–off score increases. The plot for a cut–off of 350 shows the lines almost on top of each other.

Visually, there appears to be a difference between the performance of projects above and below the cut–off, when using 150, 200, 250 or 300 as cut–off points. The observable difference becomes less significant when 350 is used as a cut–off.

If the individual performance measures of Performance–, Operating– and Customer Scores are evaluated as potential cut–off points, the relative correlation between the RAT score of a project, and each of the three performance measures can be established. Table 5.32, Table 5.33, and Table 5.34 show the average Performance Score, Operating Score and Customer Score compared to the various cut–off points.

Table 5.32 – Average Performance Score at cut–off points

		Cut–off						
	150	200	250	300	350	400	450	500
Average below cut–off	4,67	4,67	4,56	4,38	4,18	4,25	4,09	4,00
Average above cut–off	3,79	3,67	3,56	3,43	3,40	2,86	3,00	2,50
Delta	0,88	1,00	1,00	0,96	0,78	1,39	1,09	1,50

Table 5.33 – Average Operating Score at cut–off points

		Cut–off						
	150	200	250	300	350	400	450	500
Average below cut–off	3,67	4,17	4,00	3,92	3,76	3,85	3,82	3,76
Average above cut–off	3,75	3,62	3,61	3,57	3,70	3,43	3,40	3,50
Delta	–0,08	0,55	0,39	0,35	0,06	0,42	0,42	0,26

Table 5.34 – Average Customer Score at cut–off points

	Cut–off							
	150	200	250	300	350	400	450	500
Average below cut–off	4,33	4,20	4,13	3,92	3,81	3,84	3,76	3,79
Average above cut–off	3,70	3,67	3,61	3,64	3,70	3,57	3,80	3,50
Delta	0,64	0,53	0,51	0,27	0,11	0,27	–0,04	0,29

From Table 5.32, Table 5.33 and Table 5.34, graphs can be plotted to show the average performance of projects below and above the cut–off points, for the three performance measures. These graphs are shown in Figure 5.20, Figure 5.21, and Figure 5.22.

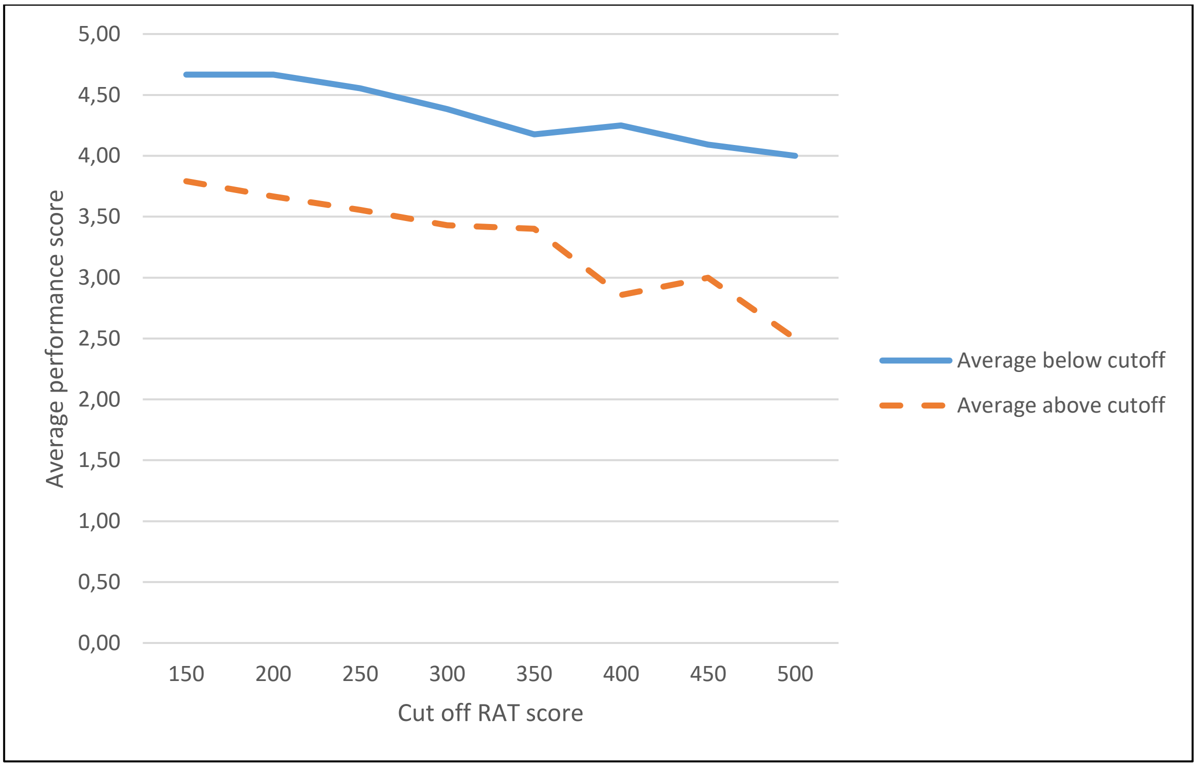


Figure 5.20 – Average Performance Score for RATs below and above cut–off points

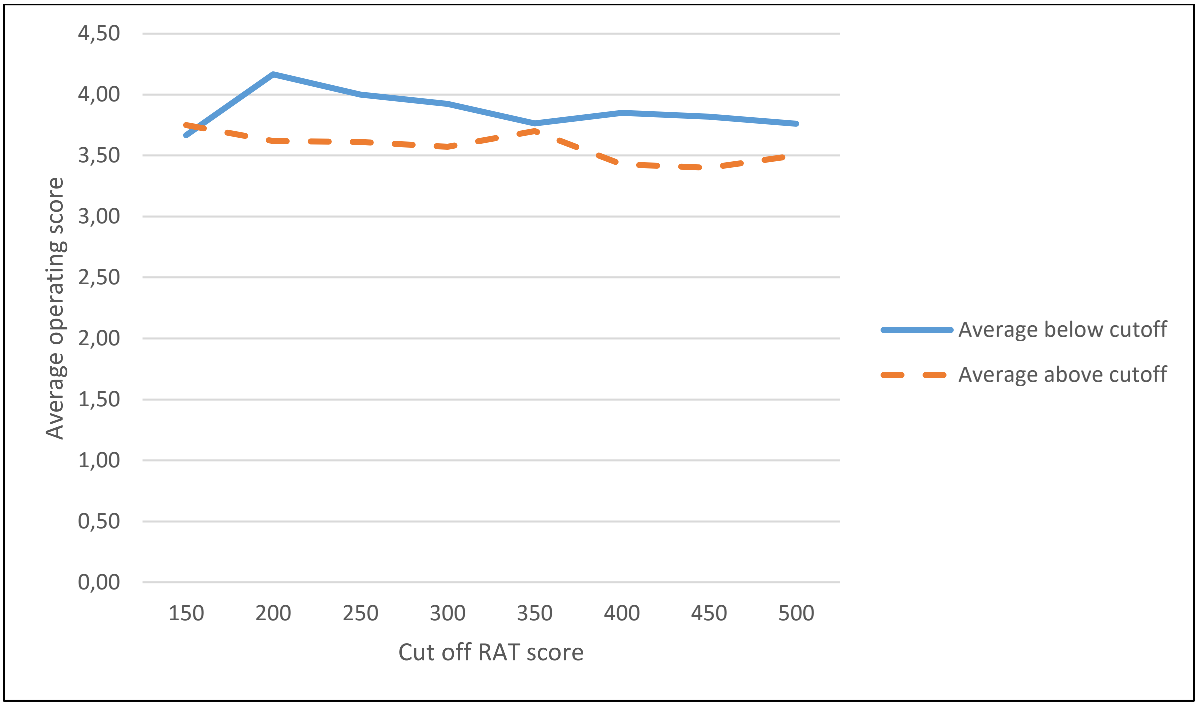


Figure 5.21 – Average Operating Score for RATs below and above cut–off points

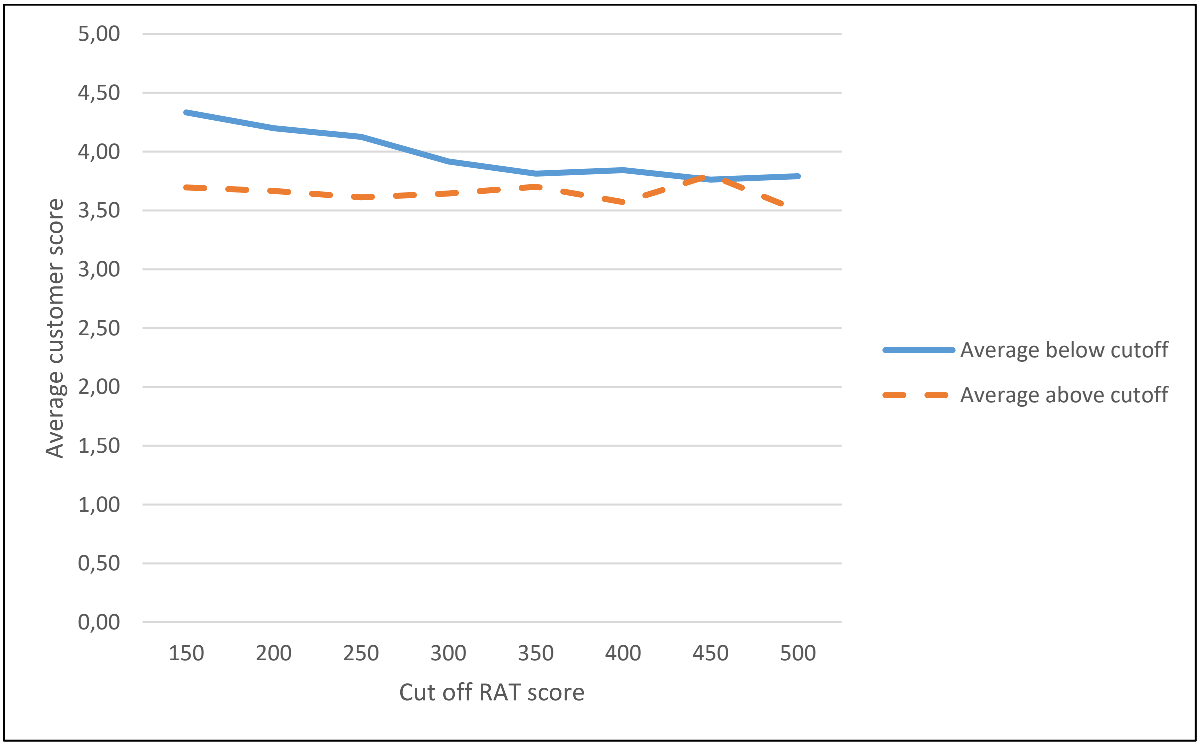


Figure 5.22 – Average Customer Score for RATs below and above cut–off points

From Figure 5.20, the Performance Scores of projects below the various cut–off RAT scores outperform those above the cut–off. The difference between the projects above the cut–off score and those below becomes more prominent as the cut–off increases.

Figure 5.21 depicts the difference between the average Operating Score of projects with RATs above and below the various cut–off scores. The average difference in Operating Score, between projects with RATs above the cut–off and those below, from Table 5.33, range from –0.08 when using 150 as the cut–off, to 0.55 when using 200 as the cut–off value. The graph shows that there is not such a pronounced difference between the two lines, as there is in Figure 5.20, but that generally, projects with a lower RAT value outperforms those with a higher value.

Figure 5.22 shows the plots for the average Customer Score of projects with RATs above and below the various cut–off points. Generally, projects with RAT scores below the cut–off points outperform those with RAT scores above the cut–off points. The difference between the two lines becomes more prominent as the cut–off value decreases from 350 towards 150.

There appears to be a positive correlation between the RAT score and all three of the performance indicators measured in this section. A regression analysis of the three indicators was conducted to test the validity of this assumption.

Regression analysis of the indicators (Performance–, Operating– and Customer Scores) was conducted versus the RAT score, and an individual graph constructed for each of these. This was done by plotting the RAT score on the X–axis and the corresponding indicator against the Y–axis. The resulting scatterplot graphs are shown in Figure 5.23, Figure 5.24, and Figure 5.25. The accompanying data is depicted in Table 5.35, Table 5.36, and Table 5.37. A bivariate linear regression was conducted for fitting a trendline through the scatterplot. The resulting equation in the form of $Y = b_1X + b_0$ was obtained, as was the *r* value and the R^2 value for each of the performance measures.

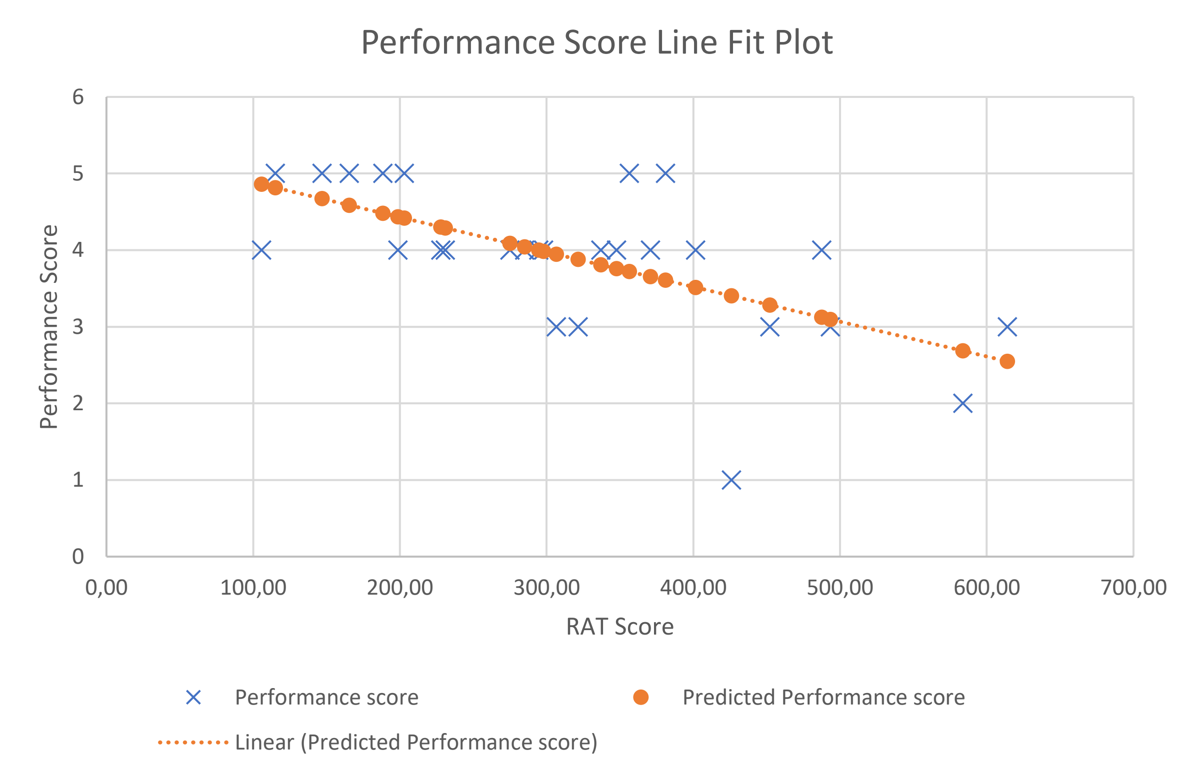


Figure 5.23 – Regression plot for Performance Score vs RAT scores

Figure 5.23 depicts the resulting scatterplot and regression line for Performance Score. The scatterplot shows a downward trend for projects with a higher RAT score.

Table 5.35 – Regression statistics for Performance Score vs RAT

Regression Statistics	
Multiple R	0,624839105
R Square	0,390423907
Adjusted R Square	0,366040863
Standard Error	0,775531052
Observations	27

	Coefficients
Intercept	5,338576997
RAT Score	–0,004543305

The equation from the regression is Y= –0.00454X + 5.3386, which suggests that a RAT score increase of 1 point would reduce the Performance Score of the project by 0.454%. This would mean that a RAT score decrease of 100 would result in a 45.5% increase in the Performance Score of the Project. Since the Performance

Score is a measure of the actual performance of the delivered project compared to the expected performance, this calculation shows that a decrease in 100 points would result in a 45.5% increase in the actual performance of the project against the expected performance.

The R^2 value of 0.390 indicates that 39.0% of the variability in the Performance Score can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning. This is further addressed in Chapter 5.

Figure 5.24 depicts the resulting scatterplot and regression line for the Operating Score. The scatterplot shows a downward trend for projects with a higher RAT score.

The equation from the regression is Y= –0.00112X + 4,0965, which suggests that a RAT score increase by 1 point would reduce the Operating Score of the project by 0.112%. This would mean that a RAT score decrease of 100 would result in an 11.2% increase in the Operating Score of the Project. Since the Operating Score is a measure of the operational performance (including capacity and availability), this calculation shows that a decrease in 100 points would result in an 11.2% increase in the operational performance of the project against the expected performance.

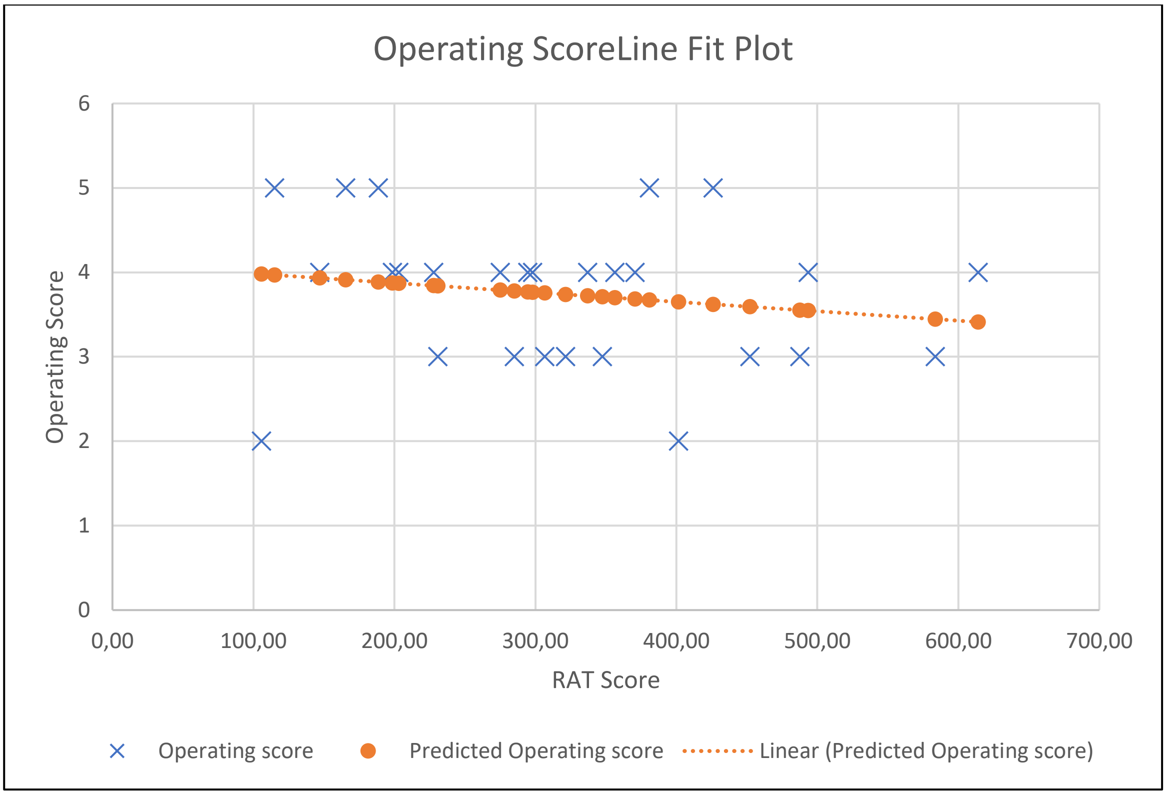


Figure 5.24 – Regression plot for Operating Score vs RAT scores

Table 5.36 – Regression statistics for Operating Score vs RAT

Regression Statistics	
Multiple R	0,173844268
R Square	0,03022183
Adjusted R Square	–0,008569297
Standard Error	0,862678939
Observations	27

	Coefficients
Intercept	4,096449465
RAT Score	–0,001114787

The R^2 value of 0.030 indicates that 3% of the variability in the Operating Score can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning. This is further addressed later in this chapter.

Figure 5.25 depicts the resulting scatterplot and regression line for Customer Score. The scatterplot shows a downward trend for projects with a higher RAT score.

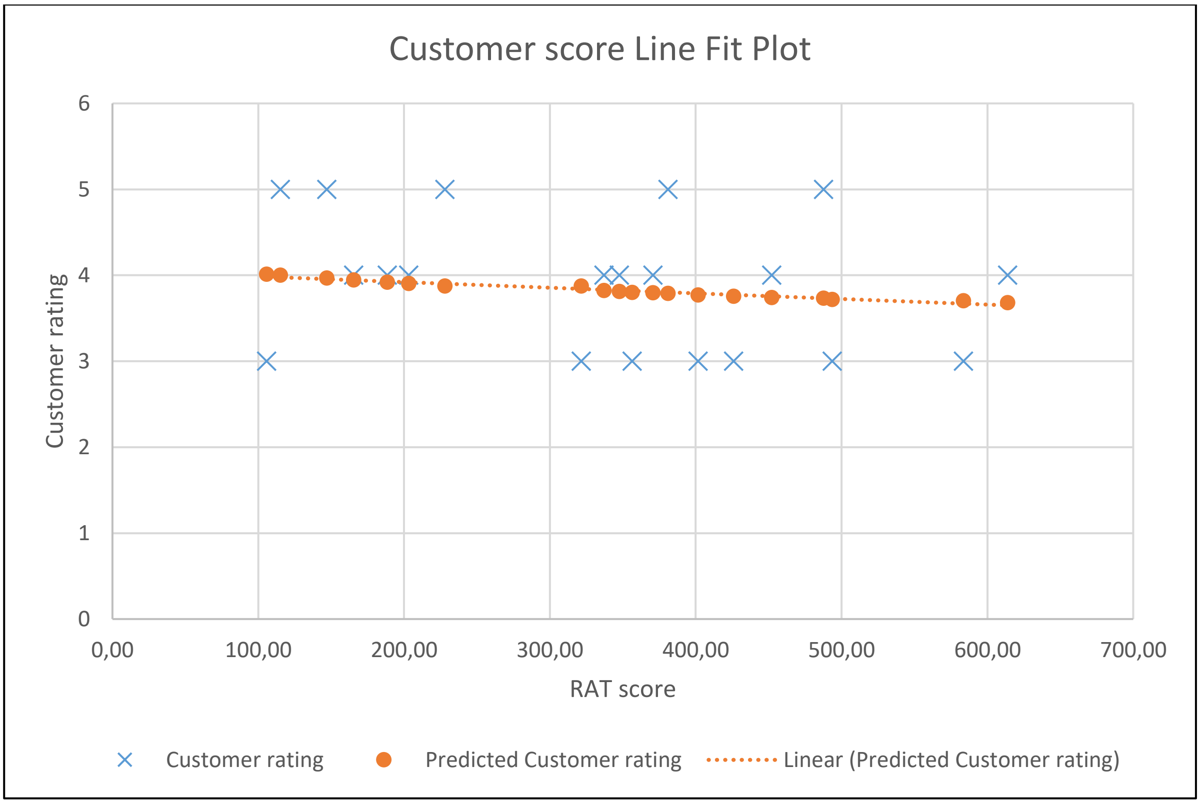


Figure 5.25 – Regression plot for Customer Score vs RAT scores

The equation from the regression is Y= –0.00111X + 4.1312, which suggests that a RAT score increase of 1 point would reduce the Customer Score of the project by 0.11%. This would mean that a RAT score decrease of 100 would result in an 11.1% increase in the Customer Score of the Project.

Table 5.37 – Regression statistics for Customer Score vs RAT

Regression Statistics	
Multiple R	0,196524311
R Square	0,038621805
Adjusted R Square	–0,00143562
Standard Error	0,765150097
Observations	26

	Coefficients
Intercept	4,131193598
RAT score	–0,00111815

The R^2 value of 0.0386 indicates that 3.86% of the variability in the Customer Score can be explained by the RAT score, which is a measure of the level of definition which the project attained during the front–end planning.

5.3 Results of the validation process

In Section 5.2, the method of validation of the RAT for Mining Projects was discussed. The data collection method, as well as the various calculations aimed at measuring the applicability of the RAT as a tool to predict project success, was described.

The three indicators which were calculated were Schedule Performance, Cost Performance and Change Performance. The RAT score of the submitted projects, along with the corresponding performance indicators, are shown in Table 5.38.

Table 5.38 – Comparison of RAT score and Performance indicators

RAT Score	Schedule	Cost	Change
105,7	0,05	–0,02	0,02
115,1	0,00	0,00	
147,0	–0,03	–0,05	0,04
165,5	–0,06	0,00	
188,5	0,09	–0,01	0,12
198,6	0,13	0,11	0,11
203,1	0,39	–0,03	0,02
228,0	0,44	–0,08	0,21
230,9	0,00	–0,04	0,11
275,1	–0,03	0,00	0,02
285,1	0,08	0,00	0,11
294,6	–0,06	0,07	0,06

	298,0	0,22	0,13	0,11
	306,7	0,28		
	321,5	0,25	0,07	0,11
	337,1	0,75	0,14	0,13
	347,6	0,23	–0,04	
	356,4	0,33	–0,15	0,28
	365,9	0,00	0,00	0,05
	381,0	–0,06	–0,06	
	401,6	0,71	0,04	0,04
	426,1	0,55	0,64	
	440,2	0,30	–0,10	0,13
	487,6	0,07	–0,36	0,64
	493,5	0,43	0,71	0,33
	583,7		0,37	
	614,0	0,00	–0,03	0,04
Average =	**318,5**	**0,19**	**0,05**	**0,13**

5.2.1 Schedule Performance

A score of 200 was determined as an appropriate cut–off point, using Schedule Performance as an indicator. Projects with a RAT score below 200 had an average Schedule Performance rating of 0.03, while those above it had an average Schedule Performance rating of 0.24. This means, on average, projects with a RAT score below 200 took on average 3% longer to complete than anticipated, while those with a RAT score above 200 took 24% longer to complete. When a regression analysis of the Schedule Performance was done, it was determined that the RAT score could explain 7.8% of the variability in Schedule Performance and that a change of 100 RAT points would result in a 5.3% change in the duration of the project

5.2.2 Cost Performance

The appropriate cut–off value for Cost Performance was not as easy to determine as for the other indicators. Although regression analysis indicated that the RAT score can explain 8.1% of the variability in Cost Performance and that a change of 100 RAT points would result in a 4.6% change in the cost of the project, there appeared to be two potential cut–off points, namely 200 and 400. By conducting a t–test, it was determined that there was not a statistically significant difference between the average Cost Performance of projects with RAT scores above and below the suggested 200 and 400 cut–off values.

The X coefficient of Schedule Performance is 0.00053 and that of Cost Performance, 0.00046. This could indicate that the QRA does not adequately cater for all the risk relating to schedule or cost. Among other things, the QRA evaluates the level of maturity of the Elements in the project's study and calculates the amount of cost and schedule contingency to be added. Thus, the amount of additional time and cost, which will be added to the project schedule and cost estimate, will decrease as the level of maturity of the study is deemed to be higher. During the QRA, separate allocations for contingency relating to time and cost is calculated. It would seem from the analysis of the regression analysis, that the impact of the maturity of the study on costs and time is underestimated during the QRA. The relative low influence of study maturity, as depicted by the RAT score, could be partly explained by the allowance for contingencies in the project schedule and cost estimate.

The level of study maturity is not the only determinant of success during project implementation. Two other factors should also be considered. Wideman (1989:109) notes that the project controls, and specifically scope control during implementation, can have a significant impact on the success of a project. Although this is addressed in several of the Elements in the RAT, the RAT only looks at the front–end planning regarding project controls. Wideman (1989) believes that the way the project is controlled during implementation is also critical to project success. If the scope of a project can change excessively during the implementation phase, this will impact the time and cost of the project and may influence other essential variables, such as quality or safety.

Frese and Sauter (2003:2) list various other contributors to sub–optimal project performance during implementation. These include:

- Lack of involvement by the end–user during implementation.
- Changing requirements and specifications.
- Lack of executive support.
- Technical incompetence.
- Lack of resources.

Frese and Sauter (2003:2) note clear responsibilities and accountabilities of team members as playing a significant role in ensuring project success. The way in which the schedule is monitored and controlled is also important.

Jiang et al. (1996:43) add the following determinants of project success during implementation, which could negatively affect the project if not in place:

- A competent Project Manager – skilled in interpersonal, technical, and administrative aspects.
- Competent and motivated team members.
- Adequate communication.
- Client acceptance – Adequate preparation to "sell" the project to the client.

There are numerous other studies that highlight the importance of the implementation and handover phase, in ensuring that the project is delivered successfully.

The other factor which may also assist in explaining the relatively low percentage of the variability in schedule and Cost Performance that can be explained by the RAT score, is that a significant number of elements in the RAT for Mining Projects do not directly relate to the schedule or Cost Performance, but are still important in determining project success. Elements such as those found in the *Project Feasibility* Category, including *Economic Evaluation* and the *Affordability / Feasibility* analysis may not necessarily impact the schedule or cost of the project implementation phase but are critical for ensuring project success and that the project is viable in the long run. These were weighted high by the participants.

Other Elements which fall into this group include those within the *Resource and Reserve Statement Category*, such as *Metallurgical Yield, Prospect drilling standards/guidelines,* and *Reserve Risk (including modifying factors).* While these are important in ensuring that the operation is successful, their impact may only be seen after the project is delivered to the end–user. They may not impact on the time or cost of the project while in implementation. This does not mean that these elements should be left out of the study. The norm in mining projects is to carry out the prospecting and testing during the early phases of the project study, and use the outcome of this process to design the operations. The economic viability is also dependent on the findings of this part of the study, and therefore should be included in the list of Elements to be studied during the front–end phase of the project.

Some of the other elements which may also not impact directly on the schedule or cost of the project during implementation, but which are critical to include during the study, are those relating to *Life of Mine Planning* (*Life of Mine Plan*, *Waste Management Plan*, *Ultimate Pit Limits Designed, Beneficiation facilities LOM plan, Materials handling LOM plan) ; Operating Philosophy (Operating costs, Production risks, Transportation strategy, Contractual consideration); Market analysis and strategy (Competitor analysis, Price risk, Market Strategy and Sales agreements); Social and Environmental Requirements (Unique mine closure plan, Land use plan post operations, Mine closure financial provision plan).;* Some of the Elements in the final Category, namely *Handover and Operational Readiness (Environmental Management Plan for Operations (EMP), Maintenance schedules, Long–term supply chain contracts)*, are also important. The Elements in the final Category may not impact the project during implementation but are important for ensuring that the operational teams can operate and maintain the facilities after the handover. Because of the sensitivity and long lead times of these Elements, the planning for this must start during the study phase of the project.

5.2.3 Change Performance

The third performance indicator, which was used to evaluate the effectiveness of the RAT in predicting project success, was Change Performance. The regression analysis indicates that the R^2 value of Change Performance is 0.363, while that of Cost Performance is 0.081 and that of Schedule Performance is 0.079. This indicates that 36.3% of the variability in Change Performance can be explained by the RAT score, while the RAT score can explain 8.1% of the variability in Cost Performance and 7.9% of the variability in Schedule Performance. The formula for Change Performance looks at the impact of costs due to changes. It evaluates the total costs of change orders against the actual project cost. The QRA process described earlier does not specifically cater for change orders, although the assumption is that the cost of changes will be funded from the contingency amount and that any time impacts will be absorbed from the schedule contingency. Therefore, the Change Performance indicator can be seen as a better indicator of the correlation between the RAT score and project success, as there are no “buffers” to absorb the impact. Apart from an R^2 of 0.363, the regression analysis of Change Performance also had an X–coefficient of 0,00081, which meant that a RAT score change of 100, would result on an impact of 8.1% on the project cost due to change orders. This compares favourably with the 4.6% change in project cost and 5.3% change in project duration which could be expected with a change of 100 points in the RAT score.

In attempting to establish an appropriate cut–off point, using the Change Performance indicator, it appeared that 150 would be an appropriate cut–off. Only three of the projects sampled in this study achieved a RAT score lower than 150, which equates to 11.1%. This may explain some of the findings of the study conducted by Price Waterhouse Cooper (PWC) in 2005, which found that only 2.5% of large capital projects in the mining industry could be described as successful when evaluated based on scope, cost, schedule and business benefits (Motta, et al., 2014).

The average RAT score for the 27 submitted projects was 319.08 at the end of the front–end loading phase. This means that if the definition of the various projects had been developed further before proceeding into detail design and implementation, the impact on time and change orders would have been as is depicted in Table 5.39.

Even though the coefficients for Schedule Performance and Change Performance is relatively small, it is clear from Table 5.39 that the potential impact of developing the definition of a mining project during the study phase to achieve RAT scores of 200 or 150 is substantial. From Table 5.39, in the sample of 27 projects, maturing all the studies of the projects to a RAT of 200, would have meant an average time saving of three months and a R 426 million average reduction in the cost impact of change orders. If the studies had been matured even further to a RAT of 150, the average impact on the schedule would have been a reduction of 3.5 months, while the average reduction of the cost impact due to change orders would have been R460 million.

By asking participants in the validation portion of the study to rate the completed projects with regards to the actual performance of the project, the operational performance and the overall success of the project, three additional indicators could be established which were also be used to evaluate the effect of the RAT score on the outcome of the completed project. These indicators were the Performance, Operating and Customer indicators. When considering the effect of the RAT score on the combination of the three indicators, it was clear that the overall performance of projects improved as the RAT score of the projects decreased.

Table 5.39 – Predicted time and change order impact using 200 and 150 as cut–off scores

	Predicted					
	RAT of 200			RAT of 150		
RAT Score	Time Impact (Months)	Cost Impact (Rands)	Change order impact (Rands)	Time Impact (Months)	Cost Impact (Rands)	Change order impact (Rands)
105,70						
115,09						
147,00						
165,54				–0,4	–R60 769 109	
188,53				–0,9	–R59 195 142	–R12 000 270
198,61				–1,4	–R390 883 892	–R86 520 639
203,13	0,0	–R2 392 017	–R86 164	–0,5	–R40 572 017	–R1 461 464
228,00	–0,7	–R70 358 015	–R23 969 459	–2,0	–R195 977 008	–R66 765 141
230,89	–0,4	–R13 613 591	–R2 524 174	–0,9	–R35 647 591	–R6 609 624
275,15	–1,3	–R2 869 161	–R97 272	–2,1	–R4 778 161	–R161 992
285,09	–1,1	–R228 973 505	–R44 743 856	–1,7	–R363 523 505	–R71 036 356
294,63	–1,7	–R293 152 050	–R34 051 836	–2,5	–R448 047 003	–R52 044 061
297,99	–0,9	–R144 239 953	–R31 709 272	–1,4	–R217 839 953	–R47 889 272
306,71	–2,0			–3,0		
321,47	–3,1	–R391 138 241	–R78 616 357	–4,4	–R552 138 241	–R110 976 357
337,12	–1,7	–R107 861 305	–R27 622 285	–2,4	–R147 191 305	–R37 694 335
347,60	–2,0	–R305 538 724	R0	–2,7	–R409 038 724	R0
401,62	–4,1	–R1 485 433 172	–R111 895 820	–5,1	–R1 853 801 172	–R139 644 520
426,11	–5,0	–R95 854 547		–6,1	–R117 051 347	
452,19	–1,3	–R487 234 556	–R102 011 583	–1,6	–R583 834 556	–R122 236 583
487,64	–18,8	–R555 719 130	–R404 898 339	–22,0	–R652 319 130	–R475 281 339
493,54	–6,5	–R6 805 496 090	–R6 839 312 220	–7,6	–R7 964 696 090	–R8 004 272 220
583,71	0,0	–R523 515 808		0,0	–R591 733 808	
613,99	–2,2	–R38 087 181	–R2 679 350	–2,5	–R42 687 181	–R3 002 950
Average	**–3,0**	**–R624 528 698**	**–R426 974 315**	**–3,5**	**–R692 840 081**	**–R460 632 353**

The three indicators on their own, when compared to the RAT score, indicated that there was a strong correlation between the RAT score of a project and the Performance Score. The Operating Score and Customer Score also correlated with the RAT score, but not as much as the Performance Score.

The Regression Statistics of the Performance Score produced an R^2 value of 0.390 (see Table 5.35), which indicates that 39% of the variability in the Performance Score of a mining project, could be explained by the RAT score. The Performance Score of a project is a measure of the extent to which the completed project has performed, compared to the expected performance. Therefore, the maturity of a mining project study could be seen as positively contributing to the performance of the completed project.

The Regression Statistics of the Operating Score produced an R^2 value of 0.030 (see Table 5.36), which indicates that 3.0% of the variability in the Operating Score of a mining project, could be explained by the RAT score. The Operating Score of a project is a measure of the extent to which the completed project has met expectations regarding the operational performance (including capacity and availability). Therefore, it can be concluded that the maturity of a mining project study contributes positively to the operational performance of the completed project.

The R^2 value (0.038) of the Customer Score (see Table 5.37) and RAT Score regression, indicates that the RAT score could explain 3.8% of the variability in the Customer Score of a mining project. The Customer Score of a project indicates the overall level of satisfaction of the end–user with the delivered project. The maturity of a mining project study could, therefore, be seen as contributing positively to the end–user satisfaction with the completed project.

While the maturity of a project study has been shown in various studies (including this one) to have a positive effect on the implementation phase of the project, there are numerous contributors to project success, which are not directly linked to the maturity of the study. Team alignment during implementation has been shown by Baiden, Price and Dainty (2006:13) to result in an improvement in project delivery efficiency. Procurement practices which do not encourage integration, are also mentioned by Baiden *et al.* as contributing to poor performance during implementation. De Wit (1988:164) mention several factors which contribute to project success. These include the commitment of the project team in achieving the goal and the motivation of the team as well as the technical and soft skills of the project manager.

Another point raised by De Wit (1988:167), is that the real success of a project is not determined by how well the implementation phase was conducted, but by the performance of the delivered project over time. De Wit mentions that changes in commodity prices may turn successful implementation projects into disasters, and *vice versa*. Similarly, a project which performs according to, or above expectation at the time of completion, would rely on constant maintenance to ensure that this performance is sustained. A potential explanation of why the Performance Score of projects appears to be much closer aligned to the RAT score, than the Customer Score and Operating Score, could be that the first indicator measures the performance of the completed projects, while the Customer Score and Operating Score measure the overall project and its capacity and availability. These may be affected by the manner in which the operational and maintenance personnel operated the project after completion.

5.3 Summary of this chapter

In this chapter, the outcomes of the study to develop a RAT for Mining Projects were discussed. The outcomes of the process to develop the weighted RAT were explored. The development of a new RAT for Mining Projects satisfied one of the objectives of the study, as well as Proposition 1. It was shown that a unique set of elements could be identified, which contributes to the successful development of a mining project's front–end loading phase and can be used to measure the level of project definition readiness. The RAT for Mining Projects consists of 180 elements, divided across four Sections and 18 Categories. Through investigation of the various Sections and Categories, the highest weighted portions of the RAT were identified, to pinpoint those Sections and Categories which should receive particular attention during the study of a mining project.

The analysis of the results of the validation process was also described in this chapter. The applicability of the RAT for Mining Projects was tested, along with six leading indicators of project success, namely the Cost–, Schedule– and Change Performance, as well as the Performance– Operating– and Customer Score indicators.

Projects with a RAT score below the suggested cut–off point of 200 took on average of 3% longer to complete than was planned, whereas projects with a RAT score of above 200 took on average of 24% longer than planned to complete. A change of 100 RAT points was shown to equate to a 5.3% change in project duration. The Cost Performance of projects proved not to correlate closely to the RAT score. One potential explanation for this, which was offered in the research report, was the use of contingencies, which are included in the cost estimate of projects, and already caters for sub–optimal Scope Definition during the project study. It was suggested that the use of contingencies be further explored in future studies, to determine how it influences the relationship between the RAT score and the Cost Performance of a project.

The correlation between the RAT score and the Change Performance of a project was found to be the strongest indicator used in this study. 36.3% of the variability in Change Performance of a project can be explained by the RAT score of the project. This is significant when one considers that the level of maturity of a study is certainly not the only determinant of project success. 150 was suggested as an appropriate cut–off point when using Change Performance as a determinant.

When comparing the impact of the RAT score on the actual performance of the project, a positive correlation could be established by comparing the performance of the completed project against the design intent. The Performance Score of the project showed the closest correlation to the RAT score, in this category. The Operating Score and Customer Score also correlated to the RAT score, but not as strongly as the Performance Score.

The potential effect on the sample projects, if the definition of the project studies had been matured further, was also examined. The average RAT score of the 27 projects used during the validation phase was 319.08. If the RAT score of the projects were lowered to 200 by studying the projects more before proceeding into implementation, the average time saving would have been three months, and the reduced impact of change orders would have been R426 million on average. In the next chapter, the study and its finding will be summarised, along with the conclusions from the study. Recommendations for potential future studies will also be made.

6. CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the final summary and conclusions of the study to produce a RAT for Mining Projects.

During the study to produce the RAT for Mining Projects, the study objectives were met, and the research propositions defended. The background of the PDRIs was provided, and the need to create a separate RAT for mining projects was substantiated. The literature review demonstrated the need for a separate RAT for mining projects and contributed to the list of Elements which make up the RAT. The methodology followed during the study was clearly described, and the applicability of the research methods was shown to be based on accepted designs of social research. The process to develop the RAT was explained, and the process of validating the RAT by testing it against completed projects was also described in the study.

6.1 Study objectives

The objectives (as explained in Section 1.7) of this study were:

1. To examine the mining industry, to identify commonalities and divergences from other industries as it relates to projects;
2. To determine which factors influence project success in mining projects, especially during the front–end planning phase; and
3. To develop a RAT for projects in the mining industry.

The first objective, to examine the mining industry to identify differences between projects in mining and other industries, was achieved mainly through a literature review (Chapter 2). Various ways in which mining projects differ from other projects were identified. These include the long study periods, high capital value, and reliance on metallurgical and geological investigations during the study. It was also found that mining projects should be located where the reserve is, instead of where production costs may be lower, as is the norm in other industries. The sheer number of Elements/factors to be considered during a project study was also found to be a differentiator between mining and other projects. The RAT for Mining Projects consists of 180 Elements, while the previous four PDRIs all have 70 Elements or less to consider during the front–end loading phase.

The second objective, to determine which factors influence project success during the front–end phase of a mining project, was achieved through a literature review (presented in Chapter 2), as well as during the initial workshops and email inputs from industry experts (described in Section 4.9.1). The list of 180 Elements which make up the RAT for Mining Projects represents these factors (See Annexure E).

The weighting process, which assigned weights to all the Elements of the RAT, was the last step in developing a RAT for Mining Projects. This was also the 3rd objective of this study. The completed RAT for Mining Projects can assist professionals in the mining project field in several ways. By creating a comprehensive, weighted list of Elements to be addressed during the front–end phase of a mining project, it can assist project team members in finding a common understanding of the areas which need to be studied, as well as the relative importance of the various Elements. Project teams can use the RAT as a self–assessment tool during any stage of the project study, for identifying the areas of the study which require more definition. Teams can also use the RAT to calculate an overall RAT rating at any stage, which will indicate the overall level of readiness of the project to proceed into the next phase of the project.

The RAT can also be used as a predictor of project success (as illustrated in Chapter 5), based on the RAT score. By making use of the maturity of each of the 180 elements to determine a single RAT score, the RAT can assist project members, as well as decision–makers such as Boards of Directors, to make informed decisions regarding the approval of projects. Because of the way in which the RAT was developed, so that the potential range of outcomes are similar to the previous PDRIs (between 70 and 1000), the projects community will readily understand the RAT score, as they have become accustomed to this scale. The suggested cut–off of 200 or 150 is also in line with the existing PDRIs and would thus be easy for the projects community to understand (Gibson and Dumon,1996:29; Cho and Gibson, 2001:116; Bingham, 2010:25; Construction Industry Institute, 2015:76).

The RAT for Mining Projects can also assist in reducing risk during project implementation and improve project team alignment and communication, as it sets a common framework for the study. By addressing all the above points, the RAT can improve the probability of a successful project.

By showing the relationship between the RAT score (and by implication the level of maturity of a study) and the Schedule Performance, Change Performance, Cost Performance, Performance Score, Customer Score and Operating Score, the analysis portion of this study highlighted the importance of the maturity of a project study, as well as the potential adverse effects of insufficient development of scope during the front–end loading phase (Presented in Section 5.2).

By highlighting the areas with low maturity, the RAT can assist project teams in proactively identifying and mitigating risks related to these. Several of the Elements in the RAT are aimed at ensuring a smooth Start–up and handover to operations and maintenance teams. Ensuring that these issues are addressed during the study of the project increases the likelihood of a smooth transition between the project and operations. This should, in return, lead to satisfied customers and better performance of the delivered project. By ensuring fewer time overruns and impacts due to change orders, the RAT will also assist in satisfying the decisionmakers that the project has delivered on its value proposition.

In summary, the RAT for Mining Projects can positively contribute to the success of a mining project. Along with all the potential qualitative improvements which were mentioned in this section, the study has established a direct correlation between the RAT score and the various performance indicators of a project.

6.2 Research problem

The main research problem was that there are no general, objective project definition and readiness criteria for mining projects.

By developing a RAT for Mining Projects, which can be freely shared as part of the CII toolkit, this problem was addressed during this study. As discussed in Chapter 4, the development of a RAT for Mining Projects went through a rigorous process, which involved a number of iterations of consulting various industry experts (both mining houses and Engineering, Procurement, Construct and Manage companies) to come up with a final list of Elements, Sections and Categories. Once the list was established, weights were assigned to the various Elements by asking industry experts to indicate the relative importance of the various elements, in ensuring success during implementation. The process resulted in a weighted RAT for Mining Projects.

The process, as described in Chapter 4, is a mixed–method research methodology, as it depended on both qualitative and quantitative research. This process was adapted from the methodology followed during the previous PDRI studies. The first elements to be included in the proposed RAT for Mining Projects were identified through a literature review (qualitative study). The finalization of the unweighted check sheet, which forms the basis of the RAT was determined through various focus groups and interviews (qualitative research). Quantitate research methods were used to assign weights to the various elements, and validate the tool against completed projects..

In order to ensure that the newly created RAT for Mining Projects was reliable, the tool was validated by testing it against completed projects. The outcome of the validation process was that there was a correlation between a lower RAT score (which indicates better maturity of the study), and several of the success indicators which were meant to measure success during project implementation.

6.3 Research propositions

The two propositions which were to be tested during the study were:

Proposition 1 – A fixed and definite list of issues related to the Scope Definition of mining projects can be developed.

This proposition was tested by producing the draft tool and sharing it with various experts. Their feedback was incorporated into the final list of Scope Definition elements.

Proposition 2 – The RAT score indicates the current level of Scope Definition and corresponds to project performance. Mining projects with low RAT scores outperform projects with high RAT scores. This proposition was tested through the validation or testing process of the proposed RAT on actual projects. The key findings for both propositions are given in the next sections.

6.3.1 Proposition 1 findings

Proposition 1 states that a fixed and definite list of issues related to the Scope Definition of mining projects can be developed. This proposition was tested by attempting to define the list of Elements which should be considered during a project study. This process consisted of a literature review as described in Chapter 2 (including the previous four PDRIs), as well as a focus group and emails (shown in Annexures B and D) with industry experts, to finalise the list which made up the unweighted RAT check sheet (shown in Annexure E). Three mining houses and five EPCM companies were asked to comment on the preliminary RAT for Mining Projects list. As part of the process to develop a RAT, the unweighted RAT check sheet was distributed to 66 individuals who had significant experience in mining projects. These individuals represented project managers, engineers, and quantity surveyors, working for large mining companies as well as EPCM companies.

In total, 20 responses were received back, of which 18 were used. The 18 participants represented a combined experience of 410 years and projects to the value of R 898 billion. The average participant had 20,5 years of experience and averaged a lifetime project value of R44,9 billion. After screening the data, a final weighted RAT check sheet was developed. The RAT check sheet contained 180 Elements, in four Sections and 18 Categories. The sheet was weighted in such a manner that the potential score ranged between 1000 points (indicating no definition in any of the Elements) and 70 points (which indicated full scope development for all the Elements). The range of between 1000 and 70 was chosen to correspond with the previous PDRIs, which all ranged roughly between 1000 and 70. This phase of the study supported Proposition 1, which states that a fixed and definite list of issues related to the Scope Definition of mining projects can be developed.

The weighted RAT provides a tool that can help project teams by providing a list of Elements which need to be addressed during a mining project study. By assigning priority to the various Elements, the efforts of the project team are focused on the Elements that can contribute most to project success.

6.3.2 Proposition 2 findings

Proposition 2 states that the RAT score indicates the current level of Scope Definition and corresponds to project performance, and that mining projects with low RAT scores outperform projects with high RAT scores. This proposition was tested during the validation of the weighted RAT. After the weighted RAT was developed, it was tested on several completed projects. By calculating performance indicators for cost, schedule and change orders, as well as the Performance Score, Operating Score and Customer Score, and comparing these to the RAT scores of completed projects, it was established that the RAT score does correspond to project performance.

The indicator relating to the performance of the product against expectations was found to have the most significant correlations to the RAT score, as the RAT score could explain 39% of the variability in the Performance Indicator. This was closely followed by the impact of change orders, which were found to have the second–highest correlation to the RAT score, as t. The RAT score could explain 36.2% of the variability in Change Performance. Similarly, 8% of the variability in Cost Performance and 7.9% of the variability in Schedule Performance could be explained by the RAT score. The RAT score can explain 3.02% of the variability in the Operating Score of a project and 3.86% of the variability in the Customer Score. These results have been presented and discussed in detail in Section 5.2.

Through the validation process, it was determined that the RAT score of a project does correspond to project performance. A project with a lower RAT score will outperform those with a higher score. These results have been presented in Chapter 5.

6.4 Novel Contribution of this research

This research established a tool which can be used to evaluate the readiness of a mining project study to proceed into detail design and implementation. This was done because of the lack of a free available tool incorporating a wide number of factors to determine the status of a mining project study. The track record of mining projects is not good. Gypton (2002:40) found an average cost overrun in mining projects compared to the approved budget, of 22%. Only 2.5% of large capital projects in the mining industry could be described as successful when evaluated based on scope, cost, schedule and business benefits (Motta, O., Quelhas, O., Filho, J., Franca, S, Meirino, 2014:402).

The study created a weighted check sheet, indicating the 180 Elements which should be considered during a mining project study. These Elements are divided into Categories and Sections. By assigning weights to the various Elements, the Elements can be ranked in order of importance of the contribution to project implementation success. This can assist project teams in prioritising certain Elements, Categories or Sections, improve the RAT score of a study, and ultimately enhance the likelihood of success during implementation.

By establishing a weighted check sheet, this study also established a tool which can be used to focus the study of a mining project with a shared understanding of the Elements to be studied. In this manner, the various team members can establish common goals and focus on specific Elements during the study.

Project teams can use the RAT as a self–assessment tool for determining potentially underdeveloped areas, which may require more attention before project approval. The RAT can also be used by third–party assessors to inform decision–makers of the readiness of a mining project study to proceed into implementation.

The validation part of the study was meant to validate the correlation between the RAT score (and thus the maturity of a mining project study), and the likelihood of project implementation success. The validation process revealed a strong correlation between most of the success measures and the RAT score. The relatively low correlation between the RAT score and the Cost Performance indicated that more work can be done to understand the impact of the QRA process and the assignment of contingencies in the schedule– and cost– estimates. The number of contingencies which was included as part of the cost– and schedule– estimates, was not explicitly tested in this study.

6.5 Limitations

Although the RAT for Mining Projects does offer an exhaustive list of Elements which should be considered during the front–end loading phase of a mining project, projects are unique endeavours, and as such, the list should not be viewed as cast in stone. Project teams should feel free to add or omit Elements, based on the specifics of the project. Teams should also feel free to modify the definitions of the Elements to better suit specific projects'

A correlation has been illustrated between the RAT score and the Change Performance, Schedule Performance and Cost Performance, as well as Performance Score, Operating Score and Customer Score. However, the RAT should not be used as a predictor of these indicators. Instead, the RAT should be used as it was intended, which is to establish alignment between project members and to establish a common understanding of the risks and areas requiring further development.

While the RAT can be used at the end of the front–end planning phase of the project, to give decision–makers a view as to the readiness of the project study to proceed into the next phase, much more value can be extracted by using the tool regularly during the project study for aligning team members around the areas which require more work.

Although the RAT attempts to use an easily understood scale of between 1 and 5 to signify the level of maturity of the individual elements, there are bound to be differences of opinion regarding the maturity rating of some elements. While there will always be some measure of subjectivity in determining the precise rating of some Elements, the RAT can assist with aligning the project team around a common purpose.

6.6 Recommendation for further research

During this study, the groundwork was done to establish a RAT for Mining Projects. The RAT was developed and tested on completed projects. The sample size, which was used to assign weights to the individual Elements, as well as the sample size used to validate the RAT, was relatively small. Future studies could continue this research by gathering more responses, especially on completed projects.

It was noted during this study that the use of cost and schedule contingencies, which are calculated via the QRA process, may distort some of the indicators which were used to illustrate project success as it relates to the RAT score. In future, questions regarding the amount of contingency (cost and schedule) which allowed in the project, and how this was used during the implementation of the project, can be added to the questionnaire, thereby allowing for a better understanding of the correlation between the RAT score and project success. A future study into the allowance for contingencies against that which was used, may result in a more accurate allocation of contingencies.

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8. ANNEXURES

8.1 Annexure A – Initial list which was sent to mining houses.

The initial list of Elements, Categories and Sections with sources, which was sent to mining houses for their input

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		
A	**BUSINESS STRATEGY**	**Source**
A.1	Business Justification	PDRI building projects
A.2	Business Plan	PDRI building projects
A.3	Economic Analysis	PDRI building projects
A.4	Project Objective Statement	PDRI building projects
A.5	Project Strategy	PDRI building projects
A.6	Affordability/Feasibility	PDRI Industrial projects
A.7	Social Issues	PDRI Industrial projects
A.8	Funding & Programming	PDRI Infrastructure projects
A.9	Contingencies	PDRI Infrastructure projects
A.10	End–User Requirements	Anglo American
A.11	Geopolitical risks	Botin (2009: 210)
A.12	Environmental Risks	Rudenno (2012: 23)
A.13	Nationalization risks	Park & Matunhire (2011:415)
A.14	Legal risks including stability of law	Anderson *et al.* (2000: 3)
A.15	Foreign investment law	Anderson *et al.* (2000: 3)
A.16	Regulation of industry	Botin (2009: 210)
A.17	Constitutional recognition of rights	Botin (2009: 210)
A.18	Due diligence	Anderson *et al.* (2000: 3)
A.19	Partnership and joint ventures	Anderson *et al.* (2000: 3)
A.20	Risk insurance	Anderson *et al.* (2000: 3)
A.21	Fiscal stability agreement	Anderson *et al.* (2000: 3)
A.22	Bilateral investment treaties	Anderson *et al.* (2000: 3)
A. 23	Corporate Social Responsibility plan	Campbell (2011:2)
A. 24	Indigenous Participation Plan	Rudenno (2012: 2)
A. 25	Social License to Operate	Prno & Slocombe (2012: 347)
A. 26	Sustainable development plan	Hillson & Murck (2000: 234)
A. 27	Commercial framework agreements (Take or pay etc)	Hillson & Murck (2000: 234)
B	**RESERVE CALCULATION**	
B.1	Site Selection Considerations	PDRI building projects
B.2	Metallurgical yield	Rudenno (2012: 378)
B.3	Reserve risks	Park & Matunhire (2011:413
B.4	Grade engineering	Ernest & Young, 2015

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION I – BASIS OF PROJECT DECISION		
C	**PRODUCTION METHOD AND CAPACITY**	**Source**
C.1	Operating Philosophy	PDRI building / Infrastructure / Industrial projects
C.2	Design Philosophy	PDRI Building / Infrastructure projects
C.3	Operating costs	Rudenno (2012: 2)
C.4	Open–pit vs Underground vs Combination	Bakhtavar, et al.(2009: 485)
C.5	Mining methods	Bakhtavar, et al.(2009: 485)
C.6	Production risks	Park & Matunhire (2011:415)
C.7	Life of mine plan	Park & Matunhire (2011:413)
C.8	Catalogue of operating plans	Del Castillo & Dimitrakopoulos (2014: 208)
gielC.9	Waste plan	Bakhtavar, E., Shahriar, K. & Oraee, K., 2009
C.10	Push backs plan	Bakhtavar, E., Shahriar, K. & Oraee, K., 2009
C.11	Haul roads	Bakhtavar, E., Shahriar, K. & Oraee, K., 2009
C.12	Cut–off grade strategy	Dagdelen (2001:117)
C.13	Ultimate pit limits designed	Del Castillo & Dimitrakopoulos (2014: 207)
C.14	Economic block values determination	Dagdelen, K., 2001
C.15	Transportation strategy	Rudenno (2012: 23
C.16	Contractual considerations	Anderson *et al.* (2000:3)
C.17	Mining law	Anderson *et al.* (2000:3)
C.18	Level of mechanization	Rudenno (2012: 2)
D	**REVENUE GENERATION**	
D.1	Market Strategy	Kuhn & Visser (2014:106
D.2	Price risks	Kuhn & Visser (2014:106
D.4	Demand risks	Kuhn & Visser (2014:106
D.5	Foreign exchange risks	Park & Matunhire (2011:415)
D.6	Currency convertibility	Park & Matunhire (2011:415)
D.7	Tax implications (VAT, corporate tax rates, resource rent tax)	Park & Matunhire (2011:415)
D.8	Value–Analysis Process	Dagdelen (2001:117)
D,9	Correct Discount Rate	Park & Matunhire (2011:413)
D.10	Royalties and other government charges	Runge (1998: 163)
D.11	Hedging	Anderson *et al.* (2000:3)
D.12	Import and export law	Park & Matunhire (2011:415)

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION I – BASIS OF PROJECT DECISION		
E	**PROJECT CONSIDERATIONS**	**Source**
E.1	Expected Project Life Cycle	PDRI Industrial projects
E.2	Completion risks	Park & Matunhire (2011:415)
E.3	Value–Analysis Process	Cardin et al. (2008: 65)
E.4	Real Options analysis	Del Castillo & Dimitrakopoulos (2014: 208)
E.5	Project Design Criteria	PDRI Building / Industrial / Small Industrial projects
E.6	Scope of Work Overview	PDRI Building projects
E.7	Project Schedule	PDRI Industrial projects
E.8	Project Cost Estimate	PDRI Building / Small Industrial projects
E.9	Investment Studies & Alternatives Assessments	PDRI Infrastructure projects
E.10	Key Team Member Coordination	PDRI Infrastructure projects
E.11	Public Involvement	PDRI Infrastructure projects
E.12	Evaluation of Compliance Requirements	PDRI Infrastructure projects
E.13	Existing Environmental Conditions	PDRI Infrastructure projects
E.14	Environmental Process determined	Barnes et al(2010: 1)
E.15	Environmental Scope determined	Barnes et al(2010: 1)
E.16	Environmental scope of assessment determined	Barnes et al(2010: 1)
E.17	Determination of Utility Impacts	PDRI Infrastructure projects
E.18	Lead/Discipline Scope of Work	PDRI Infrastructure / Industrial / Small Industrial projects
E.19	Violence and terrorism	Anderson *et al.* (2000: 1)
E.20	Contracting strategy	Anderson *et al.* (2000:3)
E.21	Indigenous participation	O'Faircheallaigh & Corbett (2005: 630)
E.22	Ability to appoint expatriates	Pritchard (2005: 3)
E.23	Procurement of local and foreign materials, services, and equipment	Pritchard (2005: 3)
E.24	Housing and transport of employees	Rudenno (2012: 2)
E.25	Custom duties	Anderson *et al.* (2000:3)
F	**PROJECT SCOPE**	
F.1	Project Objectives Statement	All four previous PDRIs
F.2	Site Characteristics Available vs. Required	PDRI Industrial. Infrastructure projects
F.3	Project Scope Definition	PDRI Industrial. Infrastructure projects

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION I – BASIS OF PROJECT DECISION		
G	**VALUE IMPROVING PRACTICES**	**Source**
G.1	Process Simplification	PDRI Industrial projects
G.2	Design & Material Alternatives Considered/Rejected	PDRI Industrial projects
G.3	Constructability Procedures	PDRI Infrastructure projects
G.4	Value Engineering Procedures	PDRI Infrastructure projects
G.5	Design to capacity	Anglo American
G.6	Classes of facility quality	Anglo American
G.7	Energy optimisation	Anglo American
G.8	Waste minimisation	Anglo American
G.9	3D / 4D design	Anglo American
G.10	Lessons learned and other knowledge management interventions	Anglo American
G.11	Cleaner Production	Hillson & Murck (2000: 229)
H	**MINE CLOSURE PLAN**	
H.1	Unique mine closure plan	Stacey, et al. (2010: 380)
H.2	Land use plan post operations	Stacey, et al. (2010: 380)
H.3	Social expectations register	Stacey, et al. (2010: 380)
H.4	Environmental expectations register	Stacey, et al. (2010: 380)
H.5	Political expectations register	Stacey, et al. (2010: 380)
H.6	Legal compliance register	Stacey, et al. (2010: 380)
H.7	HSE risk register	Stacey, et al. (2010: 380)
H.8	Community risk register	Stacey, et al. (2010: 380)
H.9	Business risk register	Anderson *et al.* (2000: 3)
H.10	Developmental opportunity register	Stacey, et al. (2010: 380)
H.11	Sustainability operating plan	Campbell (2011:2)
H.12	Stakeholder engagement plan	Campbell (2011:2)
H.13	Stakeholder development plan	Campbell (2011:2)
H.14	Mine closure financial provision plan	Stacey, et al. (2010: 380)
H.15	Risk–based model to calculate closure cost	Du Plessis & Brent (2006: 450)
H.16	Closure plan review and updates scheduled during Life of Mine plan	Stacey, et al. (2010: 380)
H.17	Local empowerment plan	Hillson & Murck (2000: 234)
H.18	Local skills development plan	Hillson & Murck (2000: 234)
H.19	The sustainable local infrastructure plan	Hillson & Murck (2000: 234)
H.20	Social investment plan	Hillson & Murck (2000: 234)
H.21	Economic diversification plan	Hillson & Murck (2000: 234)
H.22	Innovation and knowledge management plan	Hillson & Murck (2000: 234)

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION II – BASIS OF DESIGN		
I	**SITE INFORMATION**	**Source**
I.1	Site Layout	PDRI Building projects
I.2	Site Surveys	PDRI Building projects
I.3	Governing Regulatory Requirements	PDRI Building projects
I.4	Environmental Assessment	PDRI Building / Infrastructure projects
I.5	Permit Requirements	PDRI Industrial projects
I.6	Utility Sources with Supply Conditions	PDRI Building / Industrial projects
I.7	Fire Protection & Safety Considerations	PDRI Industrial projects
I.8	Special Water and Waste Treatment Requirements	PDRI Building projects
I.9	Geotechnical Characteristics	PDRI Infrastructure projects
I.10	Hydrological Characteristics	PDRI Industrial projects
I.11	Environmental Documentation	PDRI Infrastructure projects
I.12	Environmental Commitments & Mitigation	PDRI Infrastructure projects
I.13	Property Descriptions	PDRI Infrastructure projects
I.14	Right–of–Way Mapping & Site Issues	PDRI Infrastructure projects
I.15	Land Rights	Pritchard (2005: 3)
I.16	Mining plan	Pritchard (2005: 3)
J	**GEOTECHNICAL INFORMATION**	
J.1	Civil/Geotechnical Information	PDRI Building projects
J.2	Nature and extent of reserve over life of mine	Park & Matunhire (2011:414)
J.3	Mineralogy	Kuhn & Visser (2014: 106)
J.4	Structural Geology	Kuhn & Visser (2014: 106)
J.5	Life of mine planning	Kuhn & Visser (2014: 106)
J.6	Stripping ratios	Dagdelen, K., 2001
J.7	Reserve estimation	Park & Matunhire (2011:414)
J.8	Adequate sampling	Park & Matunhire (2011:414)
J.9	Reserve risks	Park & Matunhire (2011:415

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION II – BASIS OF DESIGN		
K	**PROJECT DESIGN PARAMETERS**	**Source**
K.1	Civil/Site Design	PDRI Building projects
K.2	Architectural Design	PDRI Building projects
K.3	Structural Design	PDRI Building projects
K.4	Mechanical Design	PDRI Building projects
K.5	Electrical Design	PDRI Building projects
K.6	Constructability Analysis	PDRI Building projects
K.7	Process Flow Sheets	PDRI Industrial projects
K.8	Specifications	PDRI Industrial / small Industrial projects
K.9	Mechanical Equipment List	PDRI Industrial projects
K.10	Specialty Items List	PDRI Industrial projects
K.11	Instrument Index	PDRI Industrial projects
K.12	Control Philosophy	PDRI Industrial / small Industrial projects
K.13	Logic Diagrams	PDRI Industrial projects
K.14	Electric Single Line Diagrams	PDRI Industrial projects
K.15	Instrument & Electrical Specifications	Identify Long Lead/Critical Equipment and Materials
K.16	Control of Access	PDRI Infrastructure projects
K.17	Safety & Hazards	PDRI Infrastructure projects
K.18	Operations/Maintenance	PDRI Infrastructure projects
K.19	Logistical engineering	Kuhn & Visser (2014: 106)
K.20	Ventilation Engineering	Kuhn & Visser (2014: 106)
K.21	Rock Engineering	Kuhn & Visser (2014: 106)

SECTION III – IMPLEMENTATION APPROACH		
L	**PROCUREMENT STRATEGY**	**Source**
L.1	Identify Long Lead/Critical Equipment and Materials	PDRI Industrial projects
L.2	Procurement Procedures and Plans	PDRI Building / Industrial projects
L.3	Procurement Responsibility Matrix	PDRI Industrial / Infrastructure projects
M	**DELIVERABLES**	
M.1	CADD/Model Requirements	PDRI Building / Industrial / Infrastructure projects
M.2	Deliverables Defined	PDRI Industrial projects
M.3	Distribution Matrix	PDRI Industrial / small industrial projects
M.4	Documentation/Deliverables	PDRI Building Infrastructure projects

Annexure A (Continued) – Initial list which was sent to mining houses.

SECTION III – IMPLEMENTATION APPROACH		
N	**PROJECT CONTROLS**	**Source**
N.1	Project Quality Assurance and Control	PDRI Building projects
N.2	Project Cost Control	PDRI Building / Infrastructure projects
N.3	Project Schedule Control	PDRI Building / Infrastructure projects
N.4	Risk Management	PDRI Building small Industrial projects
N.5	Safety, Health and Hygiene Management	O'Faircheallaigh & Corbett (2005: 630)
N.6	Environmental Management	O'Faircheallaigh & Corbett (2005: 630)
N.7	Project Change Control	PDRI Small Industrial projects
N.8	Project Implementation Plan	PDRI Building / Industrial / Infrastructure projects
N.9	Sustainability and Community Relations	Kirsch (2010: 88)
O	**PROJECT IMPLEMENTATION PLAN**	
O.1	Owner Approval Requirements	All four previous PDRIs
O.2	Engineering/Construction Plan & Approach	PDRI Industrial projects
O.3	Pre–Commissioning Turnover Sequence Requirements	PDRI Industrial projects
O.4	Start–up Requirements	PDRI Industrial projects
O.5	Training Requirements	PDRI Industrial projects
O.6	Project Organization	PDRI Building projects
O.7	Project Delivery Method	PDRI Building / Infrastructure projects
O.8	Design/Construction Plan and Approach	PDRI Building projects
O.9	Substantial Completion Requirements	PDRI Building projects
O.10	Safety Procedures	PDRI Building / Infrastructure projects
O.11	Computing & CADD/Model Requirements	PDRI Infrastructure projects
O.12	Design/Construction Plan & Approach	PDRI Infrastructure projects
O.13	Intercompany and Interagency Coord. & Agreements	PDRI Infrastructure projects
O.14	Deliverables for Design and Construction	PDRI Small Industrial projects
O.15	Deliverables for Project Commissioning/Closeout	PDRI Small Industrial projects
O.16	Labour and Skilled resources plan	Anderson *et al.* (2000: 9)

8.2 Annexure B – Responses from mining houses

Inputs from Participant 1

Email response from Participant 1 from mining house 1

Hi Hardus,
I had a look at the document and concur with *(name of participant)* below that this is a very comprehensive list. At the time when I had a look at it, I thought some elements might be light and wanted to suggest some inclusions, but I think it will defeat the purpose and would over complicate the intent. I then forwarded the document to two of our Project experts working with this on a daily basis and the feedback was also very positive. I have included comments and highlighted them, hope it will help.
Regards

RAT for Mining Projects	
SECTION I – BASIS OF PROJECT DECISION	
B	**RESERVE CALCULATION**
B.1	Site Selection Considerations
	Resource estimation
B.2	Metallurgical yield
B.3	Reserve risks (Sterilisation, method impact, location)
B.4	Grade engineering
E	**PROJECT CONSIDERATIONS**
E.1	Expected Project Life Cycle
E.2	Completion risks
E.3	Value–Analysis Process
E.4	Real Options analysis
E.5	Project Design Criteria
E.6	Scope of Work Overview
E.7	Project Schedule
E.8	Project Cost Estimate
E.9	Investment Studies & Alternatives Assessments
E.10	Key Team Member Coordination
E.11	Public Involvement
E.12	Evaluation of Compliance Requirements
E.13	Existing Environmental Conditions

Annexure B (Continued) – Responses from mining houses
Inputs from participant 1

SECTION I – BASIS OF PROJECT DECISION	
E	**PROJECT CONSIDERATIONS**
E.15	Environmental Scope determined
E.16	Environmental scope of assessment determined
	Environmental Licenses (IWUL, Air, EMPR)
E.17	Determination of Utility Impacts
E.18	Lead/Discipline Scope of Work
E.19	Violence and terrorism
E.20	Contracting strategy
E.21	Indigenous participation
E.22	Ability to appoint expatriates
E.23	Procurement of local and foreign materials, services, and equipment
E.24	Housing and transport of employees
E.25	Custom duties
SECTION II – BASIS OF DESIGN	
SECTION III – IMPLEMENTATION APPROACH	
L	**PROCUREMENT STRATEGY**
L.1	Identify Long Lead/Critical Equipment and Materials
L.2	Procurement Procedures and Plans
L.3	Procurement Responsibility Matrix
	Contracting strategy and risk relating to strategy
	Project implementation strategy and risk

Inputs from Participant 2 – See Notes from Expert

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		Notes from Expert
A	**BUSINESS STRATEGY**	
A.1	Business Justification	I assume Business Justification refers to project opportunity/problem statement?
A.2	Business Plan	Identifying and evaluation of different business alternatives
A.3	Economic Analysis	
A.4	Project Objective Statement	
A.5	Project Strategy	Strategic fit of the project within bigger organisation
A.6	Affordability/Feasibility	
A.7	Social Issues	
A.8	Funding & Programming	
A.9	Contingencies	

Annexure B (Continued) – Responses from mining houses

Inputs from participant 2 – see Notes form Experts

SECTION I – BASIS OF PROJECT DECISION		Notes from Expert
A.10	End–User Requirements	
A.11	Geopolitical risks	
A.12	Environmental Risks	Including Environmental timeline risks (e.g. government not adhering to own timelines)
A.13	Nationalization risks	
A.14	Legal risks including stability of law	
A.15	Foreign investment law	
A.16	Regulation of industry	
A.17	Constitutional recognition of rights	
A.18	Due diligence	
A.19	Partnership and joint ventures	
A.20	Risk insurance	
A.21	Fiscal stability agreement	
A.22	Bilateral investment treaties	
A. 23	Corporate Social Responsibility plan	
A. 24	Indigenous Participation Plan	
A. 25	Social License to Operate	
A. 26	Sustainable development plan	
A. 27	Commercial framework agreements (Take or pay etc)	
B	**RESERVE CALCULATION**	
B.1	Site Selection Considerations	Obtaining reserves/mining right including the cost and risks relating to this
B.2	Metallurgical yield	Prospect drilling standard/guideline
B.3	Reserve risks	Prospect drilling plan
B.4	Grade engineering	Geological model (structure, qualities etc.) => geological conditions

Annexure B (Continued) – Responses from mining houses

Inputs from participant 2 – See Notes from Expert

SECTION I – BASIS OF PROJECT DECISION		Notes from Expert
C	**PRODUCTION METHOD AND CAPACITY**	
C.1	Operating Philosophy	
C.2	Design Philosophy	
C.3	Operating costs	
C.4	Open–pit vs Underground vs Combination	
C.5	Mining methods	Equipment selection to fit geological conditions and mining method
C.6	Production risks	
C.7	Life of mine plan	
C.8	Catalogue of operating plans	
C.9	Waste plan	
C.10	Push backs plan	
C.11	Haul roads	
C.12	Cut–off grade strategy	
C.13	Ultimate pit limits designed	
C.14	Economic block values determination	
C.15	Transportation strategy	
C.16	Contractual considerations	
C.17	Mining law	
C.18	Level of mechanization	
E	**PROJECT CONSIDERATIONS**	
E.1	Expected Project Life Cycle	Assumption register
E.2	Completion risks	
E.3	Value–Analysis Process	
E.4	Real Options analysis	
E.5	Project Design Criteria	
E.6	Scope of Work Overview	
E.7	Project Schedule	
E.8	Project Cost Estimate	
E.9	Investment Studies & Alternatives Assessments	

Annexure B (Continued) – Responses from mining houses

Inputs from participant 2 – see Notes from Expert

SECTION I – BASIS OF PROJECT DECISION		Notes from Expert
E.10	Key Team Member Coordination	
E.11	Public Involvement	Stakeholder engagement plan
E.12	Evaluation of Compliance Requirements	
E.13	Existing Environmental Conditions	
E.14	Environmental Process determined	
E.15	Environmental Scope determined	
E.16	Environmental scope of assessment determined	
E.17	Determination of Utility Impacts	
E.18	Lead/Discipline Scope of Work	
E.19	Violence and terrorism	
E.20	Contracting strategy	
E.21	Indigenous participation	
E.22	Ability to appoint expatriates	
E.23	Procurement of local and foreign materials, services, and equipment	
E.24	Housing and transport of employees	
E.25	Custom duties	

Inputs from Participant 3 – Notes emailed

This is a very comprehensive list (We can perhaps provide the *(Company name)* Project Quality Assurance Review guideline that provides deliverables per track per phase). I am not sure if this guideline could possibly be viewed as IP) We normally (depending on the phase and type of project) also cover:

1. Project Charter and Mandate (Maybe the Project Scope part in the PDRI);
2. Governance and Control (Internal approvals);
3. Securing resources;
4. Decision register;
5. Alternative business solution identification and evaluation;
6. Next phase implementation plans
7. The risk to or Impact on other projects and/or divisions.

I hope that this can help and that it is what you had in mind

8.3 Annexure C – RAT updated after mining house inputs

RAT for Mining Projects	
SECTION I – BASIS OF PROJECT DECISION	
A	**PROJECT STRATEGY**
A.1	Project Justification
A.2	Project Charter and Mandate
A.3	Governance and control (internal approval process defined)
A.4	Project Objective Statement
A.5	Alternatives identified and evaluated
A.6	Project Strategy
A.7	Strategic fit of the project in organisation
A.8	End–User Requirements
A.9	Due diligence
A.10	Partnership and joint ventures
A.11	Risk insurance
A.12	Commercial framework agreements (Take or pay etc)
B	**COUNTRY RISK**
B.1	Social Issues
B.2	Geopolitical risks
B.3	Environmental Risks including timeline risks
B.4	Nationalization risks
B.5	Legal risks including stability of law
B.6	Foreign investment law
B.7	Regulation of industry
B.8	Constitutional recognition of rights
B.9	Fiscal stability agreement
B.10	Bilateral investment treaties
B.11	Social License to Operate
B.12	Indigenous Participation Plan
B.13	Sustainable development plan
B.14	Violence and terrorism
B.15	Indigenous participation
B.16	Ability to appoint expatriates
B.17	Procurement of local and foreign materials, services, and equipment
B.18	Custom duties

Annexure C (Continued) – RAT updated after mining house inputs

SECTION I – BASIS OF PROJECT DECISION	
C	**PROJECT FEASIBILITY**
C.1	Resources secured (including land and mineral rights)
C.2	Cost and risk of securing resources evaluated
C.3	Business Plan
C.4	Benchmarking
C.5	Cost curve
C.6	Sensitivity analysis
C.7	Economic Analysis
C.8	Affordability / Feasibility
C.9	Funding secured
C.10	Programme
C.11	Contingencies (Capex & Opex)
D	**RESOURCE AND RESERVE STATEMENT**
D.1	Metallurgical yield
D.2	Reserve risks
D.3	Grade engineering/control
D.4	Prospect drilling standard/guideline
D.5	Prospect drilling plan
D.6	Geological conditions (Geological model, structure, qualities)
D.7	Civil / Geotechnical Information
D.8	Nature and extent of ore Reserve over life of mine
D.9	Mineralogy
D.10	Structural Geology
D.11	Life of mine planning
D.12	Stripping ratios
D.13	Reserve estimation
D.14	Adequate sampling
D.15	Topography
D.16	Hydrogeology
D.17	Contamination variance
D.18	Continuity
D.19	Overburden qualities

Annexure C (Continued) – RAT updated after mining house inputs

SECTION I – BASIS OF PROJECT DECISION	
E	**LIFE OF MINE PLANNING**
E.1	Open–pit vs Underground vs Combination
E.2	Mining methods (drilling, blasting, loading, hauling)
E.3	Equipment selection to fit geological conditions and mining method
E.4	Life–of–mine plan
E.5	Waste plan
E.6	Push back plan
E.7	Cut–off grade strategy
E.8	Ultimate pit limits designed
E.9	Economic block values determination
F	**OPERATING PHILOSOPHY**
F.1	Operating Philosophy (Outsourcing vs internal vs combination)
F.2	Design Philosophy
F.3	Operating costs
F.4	Production risks
F.5	Catalogue of operating plans
F.6	Haul roads
F.7	Transportation strategy
F.8	Contractual considerations
F.9	Mining law
F.10	Level of mechanization
G	**MARKET ANALYSIS AND STRATEGY**
G.1	Market Strategy
G.2	Price risks
G.3	Demand risks
G.4	Foreign exchange risks
G.5	Currency convertibility
G.6	Tax implications (VAT, corporate tax rates, resource rent tax)
G.7	Value–Analysis Process
G.8	Correct Discount Rate
G.9	Royalties and other government charges
G.10	Hedging
G.11	Import and export law

SECTION II – PROJECT DETAILS	
H	**PROJECT CONSIDERATIONS**
H.1	Expected Project Life Cycle
H.2	Assumption register
H.3	Completion risks
H.4	Value–Analysis Process

Annexure C (Continued) – RAT updated after mining house inputs

SECTION II – PROJECT DETAILS	
H	**PROJECT CONSIDERATIONS**
H.5	Real Options analysis
H.6	Project Design Criteria
H.7	Scope of Work Overview
H.8	Project Schedule
H.9	Project Cost Estimate
H.10	Investment Studies & Alternatives Assessments
H.11	Key Team Member Coordination
H.12	Public Involvement
H.13	Evaluation of Compliance Requirements
H.14	Determination of Utility Impacts
H.15	Lead / Discipline Scope of Work
H.16	Contracting strategy
H.17	Housing and transport of employees
H.18	Risk or impact on other projects/divisions
I	**PROJECT SCOPE**
I.1	Project Objectives Statement
I.2	Site Characteristics Available vs. Required
I.3	Project Scope Definition
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**
J.1	The unique mine closure plan
J.2	Land use plan post operations
J.3	Social expectations register
J.4	Environmental expectations register
J.5	Political expectations register
J.6	Legal compliance register
J.7	HSE risk register
J.8	Community risk register
J.9	Business risk register
J.10	Developmental opportunity register
J.11	Sustainability operating plan
J.12	Stakeholder register
J.13	Stakeholder engagement plan
J.14	Stakeholder development plan
J.15	Mine closure financial provision plan
J.16	Risk–based model to calculate closure cost
J.17	Closure plan review and updates scheduled during Life of Mine plan
J.18	Local empowerment plan
J.19	Local skills development plan
J.20	The sustainable local infrastructure plan

Annexure C (Continued) – RAT updated after mining house inputs

SECTION II – PROJECT DETAILS	
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**
J.21	Social investment plan
J.22	Economic diversification plan
J.23	Innovation and knowledge management plan
J.24	Existing Environmental Conditions
J.25	Environmental Process determined
J.26	Environmental Scope determined
J.27	Environmental scope of assessment determined
J.28	Environmental Licenses (IWUL, Air, EMPR)
SECTION III – DESIGN FOR CONSTRUCTION	
K	**SITE INFORMATION**
K.1	Site Layout
K.2	Site Surveys
K.3	Governing Regulatory Requirements
K.4	Environmental Assessment
K.5	Permit Requirements
K.6	Utility Sources with Supply Conditions
K.7	Fire Protection, emergency procedure & Safety Considerations
K.8	Special Water and Waste Treatment Requirements
K.9	Geotechnical Characteristics
K.10	Hydrological and geohydrological Characteristics
K.11	Environmental Documentation
K.12	Environmental Commitments & Mitigation
K.13	Property Descriptions
K.14	Right–of–Way Mapping & Site Issues
K.15	Land Rights
L	**PROJECT DESIGN PARAMETERS**
L.1	Civil/Site Design
L.2	Architectural Design
L.3	Structural Design
L.4	Mechanical Design
L.5	Electrical Design
L.6	Constructability Analysis
L.7	Process Flow Sheets
L.8	Specifications
L.9	Mechanical Equipment List
L.10	Speciality Items List
L.11	Instrument Index
L.12	Control Philosophy & systems
L.13	Logic Diagrams

Annexure C (Continued) – RAT updated after mining house inputs

SECTION III – DESIGN FOR CONSTRUCTION	
L	**PROJECT DESIGN PARAMETERS**
L.14	Electric Single Line Diagrams
L.15	Instrument & Electrical Specifications
L.16	Control of Access
L.17	Safety & Hazards
L.18	Operations/Maintenance
L.19	Logistical engineering
L.20	Ventilation Engineering
L.21	Rock Engineering
L.22	Water balances
L.23	Internal technical audits
L.24	External technical audits
M	**VALUE IMPROVING PRACTICES**
M.1	Process Simplification
M.2	Design & Material Alternatives Considered/Rejected
M.3	Constructability Procedures
M.4	Value Engineering Procedures
M.5	Design to capacity
M.6	Classes of facility quality
M.7	Energy optimisation
M.8	Waste minimisation
M.9	3D / 4D design
M.10	Cleaner Production
M.11	Lessons learned and other knowledge management interventions

SECTION IV – IMPLEMENTATION APPROACH	
N	**PROCUREMENT STRATEGY**
N.1	Identify Long Lead/Critical Equipment and Materials
N.2	Procurement Procedures and Plans
N.3	Procurement Responsibility Matrix
O	**DELIVERABLES**
O.1	CADD/Model Requirements
O.2	Deliverables Defined
O.3	Distribution Matrix
O.4	Documentation/Deliverables
P	**PROJECT CONTROLS**
P.1	Project Quality Assurance and Control
P.2	Project Cost Control
P.3	Project Schedule Control
P.4	Risk Management
P.5	Safety, Health and Hygiene Management

Annexure C (Continued) – RAT updated after mining house inputs

P	**PROJECT CONTROLS**
P.6	Environmental Management
P.7	Project Change Control
P.8	Project Implementation Plan
P.9	Sustainability and Community Relations
P.10	Project Audits
P.11	Decision register
Q	**PROJECT IMPLEMENTATION PLAN**
Q.1	Owner Approval Requirements and Delegated Authority
Q.2	Engineering / Construction Plan & Approach
Q.3	Project Organization
Q.4	Project Delivery Method
Q.1	Design / Construction Plan and Approach
Q.2	Safety Procedures
Q.3	Computing & CADD/Model Requirements
Q.4	Design / Construction Plan & Approach
Q.1	Intercompany and Interagency Coord. & Agreements
Q.2	Deliverables for Design and Construction
Q.3	Labour and Skilled resources plan
R	**HANDOVER & OPERATIONAL READINESS**
R.1	Pre–Commissioning Turnover Sequence Requirements
R.2	Start–up Requirements & plans
R.3	Training Requirements
R.4	Substantial Completion Requirements
R.5	Deliverables for Project Commissioning / Closeout
R.6	Resourcing & staffing for operation
R.7	Maintenance schedules
R.8	Critical spares
R.9	Start–up consumables

8.4 Annexure D – Responses from EPCM

Email from Participant 4 – EPCM

The sequence of headings includes Section 2 – Project Details then Section 3 – Design for Construction, so I am not sure where the DFS would fit in. However, essentials for Section 3 that I would include would be the following:

- Geohydrology for sizing of pit dewatering pumps
- Surface hydrology – inclusive of intensity–duration–frequency relationship, also for mining but also for drainage design (civils) and tailings management. There are water balances mentioned in Item L22, presumably this refers to process plant (process engineering) and site–wide (process streams plus hydrology)
- Environmental management plan (EMP) for construction phase – for back–to–back inclusion in construction contracts
- EMP for operational phase – in case there are requirements that feed into engineering design, for instance, emission control, particular requirements for completed stockpiles, height restrictions and others
- Foundation and materials investigation ("Geotech") for civil engineering

Geotech, hydrology and survey are normally provided in time for the DFS; however, the EMP can also have a significant impact on costs. At least a draft version should be made available for the DFS.

Trust this is of use.

Kind regards

Email from Participant 4 – EPCM

I would suggest to add Electrical Load List under section L of Mining Projects

Email from Participant 4 – EPCM

Hi Hardus,

Not much further from the team other than this. Not sure if this has been useful.

If I do get any more feedback I will pass this on.

Kind regards

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 5 – EPCM

Hardus,
When I initially worked with your questionnaire, I attempted to understand what needs to be answered (partly why I am so slow in responding). I have a deep fear/mistrust of checklists, as it always seems to be so unintelligent and puts you into a box – but at least it ensures you don't miss the obvious and may remind someone of the outliers.
Of particular interest was section I, as it should test the soundness of the business decision.
Without having done proper research some obvious questions:

- Understand the market and technology trends (at the extreme the product may become replaced, what is the impact of increased capacity in the market, etc.). How secure and mature are the take–off agreements?
- Understand micro, macro, and international environment (and associated trends) and associated legislation and resistance to operations (or demands from) and products. Social license to operate is becoming increasingly more demanding in the mining industry. It also affects your logistic channels.
- Understanding the full spectrum of resources required by the operation and is it satisfactory. The mineral resource is so dominant that HR, bulk supplies, materials and equipment availability and management aspects may not be attended to sufficiently.
- Testing that the operational facilities (including logistic channels) are of sound design, correctly specified, will not become redundant or is constructible, operable, and maintainable. (This section overlaps significantly with later sections in the questionnaire.)
- Confidence in cost estimates and financial analysis – i.e. does it make money, considering all above. Test for over–optimistic estimates. Can the project be financed?
- Test the motivation for the project, does it fit into the business portfolio, is there political support and buy–in to execute.
- Review all important risks (and appetite for it) and opportunities, does it still make good business sense? Does anyone spot a black swan, was scenario testing done?

To me, the above questions should be answered at some level in the initial section. If it is not sufficiently mature or at a palatable risk level, there may not be not much point in continuing with the following detail sections – as there is not yet a business case. I suggest that the first section needs to be tested against a similar set of criteria, whether it will achieve the required outcome. See my mind map attached – for what it is worth.
The other sections are only of a technical nature and less complex. It should though test the maturity of this work – which seems to be implicit, but attention to residual risk seems not apparent. Personally I prefer the separation of disciplines (which seems to be combined in some cases) such as project management (ala PMBok), engineering, process design, sustainable development (environmental), etc. It will also be interesting to see the question that needs to be answered by each section and subsection, again to test the desired outcome.
Your questionnaire aligns well with typical deliverables we encounter in studies. Attached my inputs to your list, which seems very insignificant following my long story above. The logic of the positioning of some items may be debatable (it is not always possible to see into the mind of the designer), but I doubt if it will make any real difference.
Good luck with this worthwhile enterprise.

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 5 – EPCM

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		Inputs from Expert
A	PROJECT STRATEGY	
A.8	Due diligence	
A.9	Partnership and joint ventures	& Shareholder buy–in
B	COUNTRY RISK	
B.1	Social Issues	
B.8	Custom duties	& logistic routes
C	PROJECT FEASIBILITY	
C.5	Contingencies (Capex & Opex)	(Consider mechanisms to test for over–optimistic estimates) Where are actual Capex (H.7?) and Opex estimates?
D	RESOURCE AND RESERVE STATEMENT	
D.7	Hydrogeology	
E	LIFE OF MINE PLANNING	
E.1	Open–pit vs Underground vs Combination	Mine design criteria
	Shaft/ramp design & men and material logistics	
E.2	Mining methods (drilling, blasting, loading, hauling)	
E.5	Waste plan	
E.6	Ultimate pit limits designed	Also, consider start–up access constraints and in–pit ramp system/strategy that may require initial design
E.7	Economic block values determination	
		Not clear how beneficiation and material handling facilities are considered?
F	OPERATING PHILOSOPHY	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	Productivity/efficiency benchmarks
F.2	Design Philosophy	
F.8	Contractual considerations	
G	MARKET ANALYSIS AND STRATEGY	
G.1	Market Strategy	Sales agreements – typical for instance where coal supplied to power station – this can be a huge effort
G.2	Price risks	
G.3	Demand risks	(and also replacement products/technologies)
G.6	Hedging	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 5 – EPCM

SECTION II – PROJECT DETAILS		Inputs from Expert
H	PROJECT CONSIDERATIONS	This section is mixing project management discipline with other technical disciplines, consider separation thereof
H.1	Expected Project Life Cycle	Project Charter
H.2	Assumption register	
H.7	Project Cost Estimate	Assume this is Study/Implementation team cost? Or is it CBE?
H.8	Investment Studies & Alternatives Assessments	
H.13	Risk or impact on other projects/divisions	
I	PROJECT SCOPE	
I.1	Project Objectives Statement	
I.2	Site Characteristics Available vs. Required	
I.3	Project Scope Definition	WBS and WBS dictionary
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	
J.1	Unique mine closure plan	
J.2	Land use plan post operations	
J.3	Social expectations register	Relocation plan (RAP)
J.4	Environmental expectations register	
J.5	Political expectations register	
J.6	Legal compliance register	Mining licence, water licence, environmental approvals (record of decision?) – for servitudes as well, land rights and ownership, etc.
J.7	HSE risk register	
J.18	Existing Environmental Conditions	
J.19	Environmental Process determined	Environmental management plan

SECTION III – DESIGN FOR CONSTRUCTION		Inputs from Expert
K	SITE INFORMATION	
K.1	Site Layout	
K.8	Right–of–Way Mapping & Site Issues	
K.9	Land Rights	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 5 – EPCM

SECTION III – DESIGN FOR CONSTRUCTION		Inputs from Expert
L	**PROJECT DESIGN PARAMETERS**	
L.1	Civil/Site Design	Design criteria
L.2	Architectural Design	
L.15	Instrument & Electrical Specifications	
L.16	Control of Access	IM (information management)
L.17	Safety & Hazards	
L.21	Rock Engineering	
L.22	Water balances	Energy efficiency, carbon footprint
L.23	Internal technical audits	
L.24	External technical audits	
M	**VALUE IMPROVING PRACTICES**	
M.1	Process Simplification	
M.2	Design & Material Alternatives Considered/Rejected	Technology trends
M.3	Constructability Procedures	
M.11	Lessons learned and other knowledge management interventions	

SECTION IV – IMPLEMENTATION APPROACH		Inputs from Expert
N	**PROCUREMENT STRATEGY**	
N.1	Identify Long Lead/Critical Equipment and Materials	Draft contracts & proforma bidders pack
N.2	Procurement Procedures and Plans	Contracting strategy
N.3	Procurement Responsibility Matrix	Procurement operation plan (POP) – probably same thing as responsibility matrix
O	**DELIVERABLES**	
O.1	CADD/Model Requirements	
O.2	Deliverables Defined	
O.3	Distribution Matrix	
O.4	Documentation/Deliverables	
P	**PROJECT CONTROLS**	
P.1	Project Quality Assurance and Control	
P.5	Safety, Health and Hygiene Management	Include security

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 5 – EPCM

SECTION IV – IMPLEMENTATION APPROACH		Inputs from Expert
P.6	Environmental Management	
P.7	Project Change Control	
P.8	Project Implementation Plan	Same as Q?
P.9	Project Audits	
P.10	Decision register	
Q	**PROJECT IMPLEMENTATION PLAN**	
Q.1	Owner Approval Requirements and Delegated Authority	Same as Charter?
Q.2	Engineering / Construction Plan & Approach	Responsibility matrix RACI
Q.3	Project Organization	Document Management Plan
Q.4	Project Delivery Method	Communication management plan
Q.5	Design / Construction Plan and Approach	
Q.6	Safety Procedures	
Q.7	Computing & CADD/Model Requirements	
Q.8	Design / Construction Plan & Approach	Same as Q2
Q.10	Deliverables for Design and Construction	
Q.11	Labour and Skilled resources plan	
R	**HANDOVER & OPERATIONAL READINESS**	
R.1	Pre–Commissioning Turnover Sequence Requirements	Commissioning plan
R.2	start–up Requirements & plans	
R.6	Resourcing & staffing for operation	Long term supply chain contracts
R.7	Maintenance schedules	
R.8	Critical spares	
R.9	start–up consumables	Operational systems and procedures to support each department

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 6 – EPCM

Hi Hardus
Please find attached our review and comments.
Items highlighted in Yellow we make some suggestions for your consideration, those in Green are good and then there are some questions raised as to additions and or simplifications for your consideration.
If there is anything you would like to discuss or something is not clear, let me and I'll try and assist further.
All the best with your PhD and thank you for the opportunity to assist.
Kind Regards

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		**Inputs from Expert**
A	**PROJECT STRATEGY**	
A.1	Project Justification	
A.2	Project Charter and Mandate	
A.3	Governance and control (internal approval process defined)	
A.5	Project Strategy	
A.6	Strategic fit of the project in organisation	
A.8	Due diligence	What is meant by Due Diligence at this point – is this internal or 3rd party review?
A.9	Partnership and joint ventures	
B	**COUNTRY RISK**	
B.1	Social Issues	
B.2	Geo–political risks	
B.3	Fiscal stability agreement	
B.4	Social License to Operate	Does this include the Mining Right? If no, then suggest this is included under the Environmental Section.
B.5	Violence and terrorism	
B.6	Ability to appoint expatriates	Possibly consider including local tax regime and withholding taxes etc.
B.7	Procurement of local and foreign materials, services, and equipment	Also add in–country infrastructure (power, water, roads, port etc.) maturity to support a project.
B.8	Custom duties	
C	**PROJECT FEASIBILITY**	
C.1	Resources secured (including land and mineral rights)	
C.2	Business Plan	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 6 – EPCM

SECTION I – BASIS OF PROJECT DECISION		Inputs from Expert
C	**PROJECT FEASIBILITY**	
C.3	Economic Analysis	
C.4	Affordability / Feasibility	Possibly consider an additional line item on how the project is to be financed (Internal, External, Equity, Debt??)
C.5	Contingencies (Capex & Opex)	
D	**RESOURCE AND RESERVE STATEMENT**	Just note that you cannot have a reserve statement if there is a low score on C (no Pre–Feasibility or Definitive Feasibility Study)
D.1	Metallurgical yield	
D.2	Reserve risks	Consider adding modifying factors as an item here or outline what reserve risks include.
D.3	Grade engineering/control	I would simply call this grade control and sampling procedures
D.4	Prospect drilling standard/guideline	
D.5	Geological conditions (Geological model, structure, qualities)	
D.6	Topography	
D.7	Hydrogeology	
E	**LIFE OF MINE PLANNING**	
E.1	Open–pit vs Underground vs Combination	
E.2	Mining methods (drilling, blasting, loading, hauling)	
E.3	Equipment selection to fit geological conditions and mining method	
E.4	Life–of–mine plan	Including schedules?
E.5	Waste plan	
E.6	Ultimate pit limits designed	
E.7	Economic block values determination	
Total	CATEGORY E (Maximum =)	
F	**OPERATING PHILOSOPHY**	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	
F.2	Design Philosophy	
F.3	Operating costs	Don't think this fits under a philosophy – the operating costs are a product of the philosophy to be employed

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 6 – EPCM

SECTION I – BASIS OF PROJECT DECISION		Inputs from Expert
F	**OPERATING PHILOSOPHY**	
F.4	Production risks	
F.5	Catalogue of operating plans	Is this safe operating procedures – not sure of this terminology.
F.6	Haul roads	Haul roads seems a bit out of place – if it is to be included here then question as to what about declines, shafts etc.
F.7	Transportation strategy	
F.8	Contractual considerations	
G	**MARKET ANALYSIS AND STRATEGY**	
G.1	Market Strategy	
G.2	Price risks	
G.3	Demand risks	
G.4	Value–Analysis Process	Is this how far one takes the project up the value chain i.e. production of concentrate or inclusion of smelter.
G.5	Correct Discount Rate	
G.6	Hedging	Include competitor analysis / where project sits on the all–in the cost curve

SECTION II – PROJECT DETAILS		Inputs from Expert
H	**PROJECT CONSIDERATIONS**	
H.1	Expected Project Life Cycle	
H.2	Assumption register	
H.3	Completion risks	Risk Register
H.4	Project Design Criteria	
H.5	Scope of Work Overview	Rather change this to – Defined Scope of Work or Work Breakdown Schedule
H.6	Project Schedule	
H.7	Project Cost Estimate	
H.8	Investment Studies & Alternatives Assessments	Rather consider using Trade–off Studies

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 6 – EPCM

SECTION II – PROJECT DETAILS		Inputs from Expert
H	**PROJECT CONSIDERATIONS**	
H.9	Key Team Member Coordination	Key Team Member Coordination Plan
H.10	Evaluation of Compliance Requirements	Use of the term evaluation not really assessing against criteria – rather state Meeting Compliance Requirements
H.11	Lead / Discipline Scope of Work	
H.12	Housing and transport of employees	Is this referring to the project team/contractors?
H.13	Risk or impact on other projects/divisions	Need to include the Level of Study Costing Completed FEL 1/2/3/4

SECTION III – DESIGN FOR CONSTRUCTION		Inputs from Expert
K	**SITE INFORMATION**	
K.1	Site Layout	
K.2	Site Surveys	
K.3	Governing Regulatory Requirements	
K.4	Utility Sources with Supply Conditions	
K.5	Fire Protection, emergency procedure & Safety Considerations	
K.6	Special Water and Waste Treatment Requirements	
K.7	Property Descriptions	
K.8	Right–of–Way Mapping & Site Issues	
K.9	Land Rights	Add a geotechnical survey to this section
L	**PROJECT DESIGN PARAMETERS**	The list seems to elaborate on certain its to a specific level and not on others. There seem to be varying levels of WBS in this summary. Need to be looked at again. This list looks like a mixture of L2/3/4 in a typical WBS.
L.1	Civil/Site Design	
L.2	Architectural Design	
L.3	Structural Design	
L.4	Mechanical Design	
L.5	Electrical Design	Add Control and Instrumentation
L.6	Constructability Analysis	
L.7	Process Flow Sheets	Add P&ID's
L.8	Specifications	What specifications – Elec / Mech / Geotech / etc. or all?
L.9	Mechanical Equipment List	
L.10	Speciality Items List	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 6 – EPCM

SECTION III – DESIGN FOR CONSTRUCTION		Inputs from Expert
L	**PROJECT DESIGN PARAMETERS**	
L.11	Instrument Index	
L.12	Control Philosophy & systems	
L.13	Logic Diagrams	
L.14	Electric Single Line Diagrams	
L.15	Instrument & Electrical Specifications	
L.16	Control of Access	
L.17	Safety & Hazards	
L.18	Operations/Maintenance	
L.19	Logistical engineering	
L.20	Ventilation Engineering	Add Compressed Air
L.21	Rock Engineering	
L.22	Water balances	
L.23	Internal technical audits	
L.24	External technical audits	
M	**VALUE IMPROVING PRACTICES**	
M.1	Process Simplification	
M.2	Design & Material Alternatives Considered/Rejected	
M.3	Constructability Procedures	Question – what is the intent here because the question is "what about the procedures"
M.4	Value Engineering Procedures	Question – what is the intent here because the question is "what about the procedures"
M.5	Design to capacity	
M.6	Classes of facility quality	Not sure of what is meant here
M.7	Energy optimisation	
M.8	Waste minimisation	
M.9	3D / 4D design	What is 4D design? Time maybe?
M.10	Cleaner Production	
M.11	Lessons learned and other knowledge management interventions	

SECTION IV – IMPLEMENTATION APPROACH		Inputs from Expert
O	**DELIVERABLES**	
O.1	CADD/Model Requirements	
O.2	Deliverables Defined	
O.3	Distribution Matrix	
O.4	Documentation/Deliverables	Does this refer to the as–built? Commissioning documents? Plan Operating Procedures etc. Maybe outline these separately.

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

Hi Hardus,
Attached my comments on the Mining rating index. Broadly my comments are:

- Combination of higher and lower level elements within an evaluation area – at times the lower level elements are a sub–area of the higher–level element
- The number of elements is possibly too high – this would increase the amount of uncertainty when scoring individually (as you have indicated) as well as increase the time to assign weights and score
- Include a column providing further information on the elements – for example, 'Haul Roads' under 'Operating Philosophy' is vague. There are other such instances which require supporting information.

Please feel free to give me a call to discuss.
Kind regard

RAT for Mining Projects		
SECTION I – BASIS OF PROJECT DECISION		Inputs of Experts
A	PROJECT STRATEGY	
A.1	Project Justification	
A.2	Project Charter and Mandate	
A.3	Governance and control (internal approval process defined)	
A.5	Project Strategy	
A.6	Strategic fit of the project in organisation	Part of Project Justification
A.8	Due diligence	Preceding event before project initiation
A.9	Partnership and joint ventures	
C	PROJECT FEASIBILITY	
C.1	Resources secured (including land and mineral rights)	
C.2	Business Plan	
C.3	Economic Analysis	
C.4	Affordability / Feasibility	
C.5	Contingencies (Capex & Opex)	Part of Economic Analysis
D	RESOURCE AND RESERVE STATEMENT	Note that there are other factors to convert a resource to a reserve – for example dilution, ore loss
D.1	Metallurgical yield	
D.2	Reserve risks	

University of Pretoria

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION I – BASIS OF PROJECT DECISION		Inputs of Experts
D	**RESOURCE AND RESERVE STATEMENT**	
D.3	Grade engineering/control	
D.4	Prospect drilling standard/guideline	
D.5	Geological conditions (Geological model, structure, qualities)	
D.6	Topography	
D.7	Hydrogeology	
E	**LIFE OF MINE PLANNING**	
E.1	Open–pit vs Underground vs Combination	
E.2	Mining methods (drilling, blasting, loading, hauling)	
E.3	Equipment selection to fit geological conditions and mining method	
E.4	Life–of–mine plan	
E.5	Waste plan	
E.6	Ultimate pit limits designed	Need to be more generic – this is limited to surface mining only
E.7	Economic block values determination	
F	**OPERATING PHILOSOPHY**	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	
F.2	Design Philosophy	
F.3	Operating costs	What about capital
F.4	Production risks	Also, risk operating
F.5	Catalogue of operating plans	
F.6	Haul roads	
F.7	Transportation strategy	
F.8	Contractual considerations	
G	**MARKET ANALYSIS AND STRATEGY**	
G.1	Market Strategy	
G.2	Price risks	
G.3	Demand risks	
G.4	Value–Analysis Process	
G.5	Correct Discount Rate	Part of Economic Analysis
G.6	Hedging	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION II – PROJECT DETAILS		Inputs of Experts
H	**PROJECT CONSIDERATIONS**	
H.1	Expected Project Life Cycle	
H.2	Assumption register	
H.3	Completion risks	
H.4	Project Design Criteria	This is covered in the Engineering Design Criteria (per discipline)
H.5	Scope of Work Overview	
H.6	Project Schedule	
H.7	Project Cost Estimate	
H.8	Investment Studies & Alternatives Assessments	
H.9	Key Team Member Coordination	
H.10	Evaluation of Compliance Requirements	
H.11	Lead / Discipline Scope of Work	
H.12	Housing and transport of employees	Part of Project Strategy
H.13	Risk or impact on other projects/divisions	
I	**PROJECT SCOPE**	
I.1	Project Objectives Statement	
I.2	Site Characteristics Available vs. Required	
I.3	Project Scope Definition	Third scope item – need to rationalise
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	Greenhouse Gas Emissions
J.1	Unique mine closure plan	
J.2	Land use plan post operations	
J.3	Social expectations register	
J.4	Environmental expectations register	
J.5	Political expectations register	
J.6	Legal compliance register	
J.7	HSE risk register	
J.8	Community risk register	
J.9	Business risk register	
J.10	Developmental opportunity register	
J.11	Sustainability operating plan	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION II – PROJECT DETAILS		Inputs of Experts
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	
J.12	Stakeholder engagement plan	
J.13	Mine closure financial provision plan	
J.14	Closure plan review and updates scheduled during Life of Mine plan	
J.15	Social investment plan	
J.16	Economic diversification plan	
J.17	Innovation and knowledge management plan	
J.18	Existing Environmental Conditions	
J.19	Environmental Process determined	

SECTION III – DESIGN FOR CONSTRUCTION		Inputs of Experts
K	**SITE INFORMATION**	
K.1	Site Layout	
K.2	Site Surveys	
K.3	Governing Regulatory Requirements	
K.4	Utility Sources with Supply Conditions	
K.5	Fire Protection, emergency procedure & Safety Considerations	
K.6	Special Water and Waste Treatment Requirements	
K.7	Property Descriptions	
K.8	Right–of–Way Mapping & Site Issues	
K.9	Land Rights	Would this include exploration and mining rights as well as water use license
L	**PROJECT DESIGN PARAMETERS**	Need Mine Design
L.1	Civil/Site Design	
L.2	Architectural Design	
L.3	Structural Design	
L.4	Mechanical Design	
L.5	Electrical Design	Include instrumentation
L.6	Constructability Analysis	
L.7	Process Flow Sheets	Process Design – Flowsheet is an outcome of the design
L.8	Specifications	
L.9	Mechanical Equipment List	Part of Mechanical Design

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION III – DESIGN FOR CONSTRUCTION		Inputs of Experts
L	**PROJECT DESIGN PARAMETERS**	
L.10	Speciality Items List	
L.11	Instrument Index	
L.12	Control Philosophy & systems	
L.13	Logic Diagrams	
L.14	Electric Single Line Diagrams	Part of Electrical Design
L.15	Instrument & Electrical Specifications	Part of Electrical Design
L.16	Control of Access	
L.17	Safety & Hazards	
L.18	Operations/Maintenance	
L.19	Logistical engineering	
L.20	Ventilation Engineering	
L.21	Rock Engineering	
L.22	Water balances	
L.23	Internal technical audits	
L.24	External technical audits	
M	**VALUE IMPROVING PRACTICES**	Materials Management, Six Sigma, Lean Manufacturing
M.1	Process Simplification	
M.2	Design & Material Alternatives Considered/Rejected	
M.3	Constructability Procedures	
M.4	Value Engineering Procedures	
M.5	Design to capacity	
M.6	Classes of facility quality	
M.7	Energy optimisation	
M.8	Waste minimisation	
M.9	3D / 4D design	
M.10	Cleaner Production	
M.11	Lessons learned and other knowledge management interventions	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION IV – IMPLEMENTATION APPROACH		Inputs of Experts
N	**PROCUREMENT STRATEGY**	
N.1	Identify Long Lead/Critical Equipment and Materials	
N.2	Procurement Procedures and Plans	
N.3	Procurement Responsibility Matrix	Consider one RACI/RACID for the entire project
P	**PROJECT CONTROLS**	Documentation Control
P.1	Project Quality Assurance and Control	
P.2	Project Cost Control	
P.3	Project Schedule Control	
P.4	Risk Management	
P.5	Safety, Health and Hygiene Management	
P.6	Environmental Management	
P.7	Project Change Control	
P.8	Project Implementation Plan	
P.9	Project Audits	
P.10	Decision register	
Q	**PROJECT IMPLEMENTATION PLAN**	Look at Anglo requirements for a PEP for further definition on this section
Q.1	Owner Approval Requirements and Delegated Authority	
Q.2	Engineering / Construction Plan & Approach	
Q.3	Project Organization	
Q.4	Project Delivery Method	
Q.5	Design / Construction Plan and Approach	
Q.6	Safety Procedures	
Q.7	Computing & CADD/Model Requirements	
Q.8	Design / Construction Plan & Approach	
Q.9	Intercompany and Interagency Coord. & Agreements	
Q.10	Deliverables for Design and Construction	
Q.11	Labour and Skilled resources plan	

Annexure D (Continued) – Responses from EPCM
Inputs from Participant 7 – EPCM

SECTION IV – IMPLEMENTATION APPROACH		Inputs of Experts
R	**HANDOVER & OPERATIONAL READINESS**	Systems integration
R.1	Pre–Commissioning Turnover Sequence Requirements	
R.2	Start–up Requirements & plans	
R.3	Training Requirements	
R.4	Substantial Completion Requirements	
R.5	Deliverables for Project Commissioning / Closeout	
R.6	Resourcing & staffing for operation	
R.7	Maintenance schedules	
R.8	Critical spares	
R.9	start–up consumables	

8.5 Annexure E – Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
A	**PROJECT STRATEGY**	**Definition**
A.1	Project Justification	The most credible justification is one where the identified benefits of doing the project are greater than the cost of doing the project
A.2	Project Charter and Mandate	In project management, a project charter, project definition, or project statement is a statement of the scope, objectives, and participants in a project
A.3	Governance and control (internal approval process defined)	Project governance is the management framework within which project decisions are made
A.5	Project Strategy	The project strategy is a direction in a project that contributes to success of the project in its environment. This includes the level of autonomy of the project from the parent organisation
A.6	Strategic fit of the project in organisation	Strategic fit expresses the degree to which an organization is matching its resources and capabilities with the opportunities in the external environment. Strategic fit explains not only how the scope of the proposed project fits within the existing business strategies of the client organization but also the compelling case for change in terms of the existing and future operational needs of the organization.
A.7	Due diligence	Project due diligence is a risk management process designed to enable you to decide if you should proceed with a project and, if so, how to do so in a way that enables you to manage the social, economic and environmental risks.
A.8	Partnership, joint ventures, and shareholder buy–in	The degree to which agreement exists on the type of partnership (if any) for the project

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
B	COUNTRY RISK	
B.1	Social Issues	Involuntary resettlement, Indigenous people, Artisanal mining, Corporate governance, and standards & Corporate social investment considerations
B.2	Geopolitical risks	The risk of political intervention and unforeseen legislation changes
B.3	Fiscal stability agreement	Fiscal stability agreements guarantee the terms and conditions that will apply to the mineral resource rights (for as long as the extractor holds the rights) and to all participating interests subsequently held by the extractor in respect of the right. In particular, such agreements protect the extractor from increases in the mining royalty rate.
B.4	Social License to Operate	the level of acceptance or approval by local communities and stakeholders of mining companies and their operations. (e.g. local communities, indigenous people) and other groups of interests (e.g. local governments, NGOs).
B.5	Violence and terrorism	Violence due to Poor labour relations and local social and economic impacts and externalities, such as high inflation and the political context
B.6	Ability to appoint expatriates	The degree to which local legislation allows the appointment of skilled expatriates to supplement skills shortages
B.7	Procurement of local and foreign materials, services, and equipment	availability of appropriate skills, materials, plant, and equipment,
B.8	Country infrastructure (power, roads, rail, water ports)	The level of maturity/availability of infrastructure and the effect thereof on the project
B.9	Custom duties & logistic routes	Understanding the cost of exporting and importing ore and beneficiated products. Having adequate stockpile planning of material and the ability to move it whenever necessary

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
C	**PROJECT FEASIBILITY**	
C.1	Resources secured (including land and mineral rights)	Who holds the title to the land, and who holds the right to mine the deposit?
C.2	Financing secured (Internal, external, equity, debt)	Project finance is a funding mechanism that relies on a future stream of cash flow from a project as the main source of repayment and uses the project's assets, contracts, rights, and interests as security for the loan.
C.3	Business Plan	An integration of logic, process, and methodologies to facilitate long term planning of mineral asset exploitation, within a strategic and market context
C.4	Economic Analysis	The method of appraisal of the estimated returns of a mining project investment and the assumptions around the certainty of the various input elements
C.5	Affordability / Feasibility	The degree to which the project is economically viable if it is designed, constructed, and operated appropriately.
C.6	Contingencies (Capex & Opex)	The estimated cost of unknowns due to risk, which is allowed for in the project cost estimate costs that will probably occur based on past experience, but with some uncertainty regarding the amount
C.7	Basis of Estimate	The purpose of the Basis of Estimate is to describe the methodology in the development of the capital cost estimate.
C.8	Scenario planning	A useful tool for understanding the range of possible futures and planning for each.
D	**RESOURCE AND RESERVE STATEMENT**	
D.1	Metallurgical yield	The expected recoverable mineral content as a ratio of the total mined ore
D.2	Reserve risks (including modifying factors)	The degree of confidence in the reserve estimate relating to the resource deposit – the level of certainty regarding the assumptions relating to recoverable resources
D.3	Grade engineering/control	This reconfiguration of the mining value chain uses mine planning, blasting, and sorting to remove low–grade ore sources prior to the costly haul and mill operations
D.4	Prospect drilling standard/guideline	The guideline which determines the drill pattern, hole spacing, type of drilling and equipment, sampling procedure and tests, based on the nature of the ore

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
D.5	Geological conditions (Geological model, structure, qualities)	the applied science of creating computerized representations of portions of the Earth's crust based on geophysical and geological observations made on and below the Earth surface. A Geo model is the numerical equivalent of a three–dimensional geological map complemented by a description of physical quantities in the domain of interest
D.6	Hydrogeology	Analysis of impacts caused by 1)the presence of a mine on the environment, 2) mine dewatering and 3) analysis of soil or water contaminated in a mining environment
E	**LIFE OF MINE PLANNING**	
E.1	Mine design criteria	The factors which will influence or restrain mine design. The interaction of these factors must be examined carefully in order to select the appropriate system. Key parameters include geologic, mechanical (equipment) and operational.
E.2	Shaft/ramp design & men and material logistics	Determination of the method to access the ore body: audits, incline shafts, vertical shafts, and declines or ramps.
E.3	Mining methods (drilling, blasting, loading, hauling)	The level to which the mining methods, including drilling, blasting, loading, and hauling has been defined and agreed upon
E.4	Equipment selection to fit geological conditions and mining method	The level to which the type of mining, transport and beneficiation equipment has been agreed upon to fit in with the geology and type of mining method
E.5	Life–of–mine plan	The Life of Mine Plan (LOMP) is the formally approved long–term plan for the mine. It establishes the framework within which all other shorter–term plans are developed
E.6	Waste management plan	documents that describe the measures that should be implemented at the site to prevent or reduce adverse environmental effects, which may result from the extractive waste disposal or treatment
E.7	Ultimate pit limits designed	The ultimate pit limit gives the shape of the mine at the end of its life. Usually, this contour is smoothed to produce the final pit outline

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
E	**LIFE OF MINE PLANNING**	
E.8	Economic block values determination	algorithms developed for optimisation of the mine layout and production scheduling, for both open pit and underground mines, are implemented on an economic block model of the ore–body
E.9	Beneficiation facilities LOM plan	A formally approved long term plan for the beneficiation facilities on a mine. It establishes the framework within which all other shorter–term plans are developed
E.10	Materials handling LOM plan	A formally approved long term plan for the materials handling facilities on a mine. It establishes the framework within which all other shorter–term plans are developed
F	**OPERATING PHILOSOPHY**	
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	The portion of the mining and beneficiation which will be carried out by an in–house team. Options include full in–house, outsourcing of all activities, or a range of combinations of these activities
F.2	Productivity / efficiency benchmarks	Agreement on a number of parameters and benchmarks which will be tracked during mining and beneficiation to ensure optimum efficiency and productivity. These can include down / uptime of plant, tons moved per machine, mean time to repair etc.
F.3	Operating costs	Has consideration been given to utilities, supplies and materials, taxes, wages and benefits, transport costs, consumables?
F.4	Production risks	Are risks identified and contingency plans developed for risk which may impact production, including financial, geological, and social factors
F.5	Catalogue of operating plans	a limited, representative set of operating plans covering the range of possible plans that would each be associated with a unique evolution of price – part of contingency planning
F.6	Haul roads	Consideration of types of trucks, operating philosophy of the road, road design requirements

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION I – BASIS OF PROJECT DECISION		
F	**OPERATING PHILOSOPHY**	
F.7	Transportation strategy	The long term plan to deal with the movement of ore and beneficiated products from the mine to the end–user / client
F.8	Contractual considerations	Outsourcing vs in in–house drilling, blasting, loading, hauling, day works. Has risk and contingencies/premium been adequately considered?
G	**MARKET ANALYSIS AND STRATEGY**	
G.1	Market Strategy & Sales Agreements	The degree to which sales agreement has been agreed in principle and marketing strategy is in place
G.2	Price risks	The perceived volatility of prices of the product
G.3	Demand risks & replacement products / technologies	The perceived threat of lower demand for products (due to redundancy of product or other reasons)
G.4	Value–Analysis Process	A discounted cash flow analysis that reasonably reflects the probable project cash flows (given an assumed set of economic assumptions, including metal prices, exchange rates, interest rates, inflation rates, etc.).
G.5	Hedging	The practice of fixing prices and exchange rates to safeguard against the negative effects of fluctuations in these indexes
G.6	Competitor analysis	An analysis of the strategies and strengths of competitors in the market

SECTION II – PROJECT DETAILS		
H	**PROJECT CONSIDERATIONS**	
H.1	Expected Project Life Cycle	The anticipated duration of the project until nameplate capacity is achieved and the project is considered as completed
H.2	Assumption register	A register stating all the assumptions made during the various activities of the project study, including assumptions regarding yield, losses, process, returns etc.
H.3	Completion risks	The risks which may cause the project to not be completed

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION II – PROJECT DETAILS		
H	**PROJECT CONSIDERATIONS**	
H.4	Project Design Criteria	The range of standards which serves as the guidelines during the design of the various structures to be constructed as part of the project
H.5	Scope of Work Overview	The level of definition to which the scope of work during the project has been defined and decomposed
H.6	Project Schedule	The project schedule is the tool that communicates what work needs to be performed, which resources of the organization will perform the work and the timeframes in which that work needs to be performed. The project schedule should reflect all of the work associated with delivering the project on time.
H.7	Project Cost Estimate	A cost estimate is the approximation of the cost of a program, project, or operation. The cost estimate is the product of the cost estimating process.
H.8	Investment Studies & Alternatives Assessments	The degree to which alternative solutions were explored before deciding on the proposed solution
H.9	Key Team Member Coordination	The level of integration between key team members
H.10	Evaluation of Compliance Requirements	The degree to which the project team has addressed the various regulatory compliance requirements
H.11	Lead / Discipline Scope of Work	The degree of clarity which was provided and established for all disciplines involved in the project
H.12	Housing and transport of employees	The level to which consideration has been given and agreements been established for housing and transport of the project team during construction
H.13	Risk or impact on other projects / divisions	Has the project team considered the impact of the proposed project on the resources of the rest of the organisation?
I	**PROJECT SCOPE**	
I.1	Project Objectives Statement	a clear and concise (high–level) statement of the goals and objectives of the project as well as the expected outcomes.

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION II – PROJECT DETAILS		
I	**PROJECT SCOPE**	
I.2	Site Characteristics Available vs. Required	The degree to which the requirements regarding site conditions has been met by the proposed location of the project
I.3	Project Scope Definition	Project scope is the part of project planning that involves determining and documenting a list of specific project goals, deliverables, features, functions, tasks, deadlines, and ultimately costs. In other words, it is what needs to be achieved and the work that must be done to deliver a project
I.4	WBS and WBS Dictionary	A Work Breakdown Structure dictionary is a document that provides a detailed information about each element in the WBS, including work packages and control accounts
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	
J.1	Unique mine closure plan	The degree to which the project team has created a complete and unique mine closure plan which addresses the specific requirements of the proposed project
J.2	Land use plan post operations	The degree to which the project team has created a complete and unique plan which addresses the use of the land after the closure and rehabilitation of the mine
J.3	Social expectations register	The level of completeness of a register which lists the expectation of interested and affected parties with regards to social aspects during all phases of the project
J.4	Relocation Action Plan	A Relocation Action Plan (RAP) is a document specifying the procedures and the actions to properly resettle and compensate affected people and communities
J.5	Environmental expectations register	A register listing all the requirements under environmental legislation, as well as a description of the manner in which this will be addressed by the project

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION II – PROJECT DETAILS		
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	
J.6	Political expectations register	A register listing all the expectation of politicians at the various level of government (including incumbents), as well as a description of the manner in which this will be addressed by the project
J.7	Legal compliance register	A register containing all the applicable legislation, with evidence of how the project addresses / will address the requirements
J.8	HSE risk register	A risk register is a tool, which enables the HSE to record its risk profile. It contains details of all high–level risks, existing controls, and additional controls /actions required. It provides a structure for collating information about risks that helps in decision making about whether or how the identified risks should be treated, managed, or monitored.
J.9	Community risk register	A register of all the risks and mitigation plans relating to community expectations, including employment, social, environmental, and other expectations
J.10	Business risk register	A risk register addressing the risks to the bigger business due to the projects, as well as mitigation plans
J.11	Developmental opportunity register	A register of opportunities to develop the affected community as part of the project and operations
J.12	Sustainability operating plan	A plan which addresses the long term achievement of Social Licence to Operate while ensuring maximum returns for the company
J.13	Stakeholder engagement plan	A plan which assists managers with effectively engaging with stakeholders throughout the life of the mine and specifying activities that will be implemented to manage or enhance engagement.

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Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION II – PROJECT DETAILS		
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**	
J.14	Mine closure financial provision plan	A risk–based model to calculate closure cost, including details of how provision will be made to cover this cost during the Life of Mine
J.15	Closure plan review and updates scheduled during Life of Mine plan	A schedule of interventions to ensure that the closure plan is reviewed and updated periodically
J.16	Social investment plan	A plan on how the project will invest in the affected community to ensure that social expectations are addressed
J.17	Economic diversification plan	A plan indicating how the project will diversify the local economy during project implementation as well as during operations, to ensure sustainability
J.18	Existing Environmental Conditions	A record of as–is environmental conditions to serve as a baseline
J.19	Environmental Process determined	The level to which the project team has defined the process to be followed to ensure that environmental requirements and expectations are met
J.20	Environmental management plan	an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented; and that the positive benefits of the projects are enhanced

SECTION III – DESIGN FOR CONSTRUCTION		
K	**SITE INFORMATION**	
K.1	Site Layout	The level to which the proposed development has been defined in terms of the layout of the site
K.2	Site Surveys	The level and accuracy to which the proposed site has been surveyed
K.3	Governing Regulatory Requirements	The level to which regulatory requirements have been taken into considerations during the design of the site layout
K.4	Utility Sources with Supply Conditions	The level to which the site layout includes the availability of utilities such as electricity and details regarding the utility such as type

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION III – DESIGN FOR CONSTRUCTION		
K	**SITE INFORMATION**	
K.5	Fire Protection, emergency procedure & Safety Considerations	The level to which the site layout includes fire protection and security planning (including fencing and access control)
K.6	Special Water and Waste Treatment Requirements	The level to which the site layout includes details regarding water and wastewater planning
K.7	Property Descriptions	The level to which the site layout includes a description of the property
K.8	Right–of–Way Mapping & Site Issues	The level to which the site layout includes information such as servitudes and shared pathways
K.9	Land Rights	The level to which the right of land use has been established
L	**PROJECT DESIGN PARAMETERS**	
L.1	Design Criteria	The level to which guidelines have been provided and agreed for the various disciplines involved in the mining project
L.2	Civil/Site Design	The level of maturity of the civil and site designs for the project
L.3	Geotechnical investigation for structures	The level of maturity of geotechnical investigation for the project
L.4	Architectural Design	The level of maturity of the architectural designs for the project
L.5	Structural Design	The level of maturity of the structural designs for the project
L.6	Mechanical Design	The level of maturity of the mechanical designs for the project
L.7	Electrical Design	The level of maturity of the electrical and instrumentation designs for the project
L.8	Constructability Analysis	Constructability (or buildability) is a project management technique to review construction processes from start to finish during the pre–construction phase. It is to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION III – DESIGN FOR CONSTRUCTION		
L	**PROJECT DESIGN PARAMETERS**	
L.9	Process Design	The design of processes for desired physical and/or chemical transformation of materials. Typical outcomes include block flow diagrams, process flow diagrams, piping and instrumentation diagrams and specifications
L.10	Specifications	Written design requirements for all major equipment items
L.11	Speciality Items List	Speciality items refer to the wide range of non–fitting items and components required for various piping, plumbing and other systems
L.12	Instrument Index	Instrument index is a document containing a list of instrument devices within a plant. Instrument index shall include tag number of all physical instruments (e.g. field instrument, physical alarm, and indicator) and pseudo instruments which commonly named “soft tag” (e.g. DCS indication, alarm, controller).
L.13	Control Philosophy & systems	The level to which the level and type of process automation has been defined, along with the system which will deliver this
L.14	Logic Diagrams	The level to which logic diagrams have been developed to present component and system operational information
L.15	IM (information management)	The level to which the information management system specifications and deliverables have been defined
L.16	Control of Access	The level to which the access control requirements, including the control and logging system, has been detailed
L.17	Safety & Hazards	The level to which hazards and safety has been addressed during the design of the project
L.18	Operations/Maintenance	The level to which design parameters have been established for operations and maintenance of the equipment on the project

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION III – DESIGN FOR CONSTRUCTION		
L	**PROJECT DESIGN PARAMETERS**	
L.19	Ventilation Engineering	The level to which ventilation engineering design parameters have been established and considered as part of the project
L.20	Rock Engineering	The level to which rock engineering design parameters have been established and considered as part of the project
L.21	Water balances	The level to which water balance design parameters have been established and considered as part of the project
L.22	Energy efficiency/carbon footprint	The level to which the energy efficiency and carbon footprint of the project has been considered
L.23	Tailings handling and storage	The level to which the tailings handling and storage has been addressed by the project team
L.24	Stormwater handling/surface hydrology	The level to which stormwater handling has been addressed by the project team
L.25	Internal technical audits	Have internal technical audits been considered and scheduled as part of the project?
L.26	External technical audits	Have external technical audits been considered and scheduled as part of the project?
M	**VALUE IMPROVING PRACTICES**	
M.1	Process Simplification	A process design technique that makes a process more feasible and manageable through dividing this process into relatively simple tasks, so that every task is carefully observed to detect and remove redundant or wasteful actions and to estimate precise time necessary for implementing corrections. This technique aims to design and plan a process in a manner that is least expensive and consistent with the process's objectives.

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION III – DESIGN FOR CONSTRUCTION		
M	**VALUE IMPROVING PRACTICES**	
M.2	Design & Material Alternatives Considered/Rejected	The level to which alternative materials and designs were considered before agreeing on the proposed materials and design
M.3	Technology trends	The level to which the project team considered trends in technology development in order to ensure that the technology implemented in the project is relevant
M.4	Design to capacity	A structured methodology to address design capacity against business needs and to eliminate "hidden capacity."
M.5	Classes of facility quality	This practice establishes what quality facility is needed to meet project objectives, based on the project life cycle and other criteria
M.6	Energy optimisation	A simulation methodology for optimizing the life cycle costs by examining power and heating requirements for a particular process. The objective is to maximize the total return based on selecting the most economical methods of heat and power recovery
M.7	Waste minimisation	Reduction of waste at source and re–use of waste for cost–effectiveness
M.8	3D / 4D design	Have the designs been captured in a system which can create 3 dimensional models (3D) and has this been coupled with a system which can connect this with the scheduling (time) to show the sequencing of construction?
M.9	Cleaner Production	Cleaner production activities include measures such as pollution prevention, source reduction, waste minimization and eco–efficiency. They involve better management and housekeeping, the substitution of toxic and hazardous materials, process modifications, and reuse of waste products. At its heart, the concept is about the prevention, rather than the control, of pollution

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION III – DESIGN FOR CONSTRUCTION		
M	**VALUE IMPROVING PRACTICES**	
M.10	Innovation and knowledge management planning	The level to which a plan has been developed by the project management team to ensure knowledge management and innovation is incorporated
M.11	Six Sigma	A set of techniques and tools for process improvement It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits
M.12	Lean Manufacturing	Lean manufacturing strives to eliminate all sources of waste (activities which do not add value) It uses techniques such as 5S, bottleneck analysis, Just in Time, KPIs, Overall Equipment Effectiveness (OEE), Root cause analysis and Value stream mapping

SECTION IV – IMPLEMENTATION APPROACH		
N	**PROCUREMENT STRATEGY**	
N.1	Identify Long Lead/Critical Equipment and Materials	The level to which materials and equipment which will take longer than normal to deliver, have been identified and prioritized
N.2	Procurement Procedures and Plans	The maturity of procurement plans
N.3	Procurement Responsibility Matrix	The level to which the delegation of authority and responsibility has been determined for the procurement during the project
N.4	Draft contracts & proforma bidders pack	The level to which contracts have been prepared in order to facilitate speedy contract placement or tendering when the project is approved
N.5	Contracting strategy	The maturity of the strategy on how to engage the various contractors involved in a mining project

Annexure E (Continued)– Final list of Elements, Categories, Sections and

Definitions

SECTION IV – IMPLEMENTATION APPROACH		
N	**PROCUREMENT STRATEGY**	
N.6	Procurement operation plan (POP)	A plan indicating the manner in which the project will address procurement. It should include the procurement objectives and milestones, breakdown of activities in accordance with the selected procurement methods, the responsibility of each participant, timelines as well as budgets and the relevant codes
O	**DELIVERABLES**	
O.1	CADD/Model Requirements	The level to which the expectations regarding Computer–Aided Design and models have been specified
O.2	Deliverables Defined	The level to which the deliverables for implementation has been defined
O.3	Distribution Matrix	The level to which the distribution of information, data and reports has been defined
O.4	Documentation/Deliverables	The level to which documentation has been defined which must be produced during the project
P	**PROJECT CONTROLS**	
P.1	Project Quality Assurance and Control	The maturity and level of detail in the Quality Assurance and Control domain
P.2	Project Cost Control	The maturity and level of detail of Cost Control planning
P.3	Project Schedule Control	The maturity and level of detail of Schedule Control planning
P.4	Risk Management	The maturity and level of detail of Risk Management planning
P.5	Safety, Health, Hygiene and Security Management	The maturity of the Safety, Health, Hygiene and Security Management processes
P.6	Environmental Management	The maturity and level of detail of Environmental Management control system
P.7	Project Change Control	The maturity and level of detail of Project Change Control, including the definition of scope control processes and delegation of authority
P.8	Project Audits	The level to which audits have been planned as part of the project control function

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION IV – IMPLEMENTATION APPROACH		
P	**PROJECT CONTROLS**	
P.9	Decision register	The degree to which the project makes use of a decision register to capture changes and decisions, as well as the reasons and authorisation of these
Q	**PROJECT IMPLEMENTATION PLAN**	
Q.1	Engineering / Construction Plan & Approach	The maturity of a plan which indicates how construction and engineering will occur on–site
Q.2	Project Organization	A document indicating the organisational hierarchy, with the roles and responsibilities of each individual, clearly indicated
Q.3	Responsibility matrix RACI	A chart which shows the relevant role–players, including the influence of each, and what the individuals are responsible and accountable for, as well as who should be informed of decisions vs those who should approve it
Q.4	Document Management Plan	The purpose of the Document Management Plan is to capture how documents will be managed throughout the project life cycle. Documents refer to all project documentation and artefacts. Document management is the process of organizing, storing, protecting, and sharing documents. The Document Management Plan describes how to manage both the hard copy and electronic repositories of documents, historical information, and provides a consistent approach to the creation, update, and format of documents
Q.5	Communication management plan	The purpose of the Communications Management Plan is to define the communication requirements for the project and how the information will be distributed and deals with the what, how, who, confidentiality, standards and templates, as well as escalation of communication issues on the project

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION IV – IMPLEMENTATION APPROACH		
Q	**PROJECT IMPLEMENTATION PLAN**	
Q.6	Project Delivery Method	A project delivery method is a system used by an agency or owner for organizing and financing design, construction, operations, and maintenance services for a structure or facility by entering into legal agreements with one or more entities or parties. It could include Design–Bid–Build, Design–build, or Build–operate–transfer agreements
Q.7	Design / Construction Plan and Approach	A plan that details the how who and by when of the project implementation. It includes a description of the project, the team responsible for executing the work, the construction process, take over requirements and process and the evaluation after takeover
Q.8	Safety Procedures	Safety procedures are designed to keep employees, visitors, and customers safe while helping to reduce the stress associated with the work area
Q.9	Intercompany Agreements	Intercompany agreements are arrangements made between two businesses owned by the same company. Typically, these are two divisions under the same corporation. This agreement states how intercompany sales or transfers of goods, services or time are handled.
Q.10	Deliverables for Design and Construction	A detail list of what design information should be made available (including schedules) to enable the construction of the proposed project without delays
Q.11	Labour and Skilled resources plan	A plan detailing the engagement/sourcing and training of adequate skilled staff to address the requirements of the project.

Annexure E (Continued)– Final list of Elements, Categories, Sections and Definitions

SECTION IV – IMPLEMENTATION APPROACH		
R	**HANDOVER & OPERATIONAL READINESS**	
R.1	Commissioning plan	It outlines the overall process, schedule, organization, responsibilities, and documentation for the commissioning process.
R.2	Start–up Requirements & plans	The level of detail in listing and planning for start–up of the completed project. This includes ensuring that operational staff, equipment, and consumables are available
R.3	Training Requirements	The level to which training of operational and maintenance personnel has been finalised
R.4	Substantial Completion Requirements	The identification of and agreement on critical milestones which will signify the completion of sections of work
R.5	Deliverables for Project Commissioning / Closeout	The identification and agreement on what is required to complete the commissioning and closeout of the project
R.6	Long term supply chain contracts	The establishment of long term contracts to supply material, labour and services required for the operation of the mine after the project is completed
R.7	Resourcing & staffing for operation	A plan detailing the engagement/sourcing and training of adequate skilled staff to address the requirements of the operations post project completion
R.8	Maintenance schedules	Schedules which indicates how by whom and when plant and equipment should be maintained
R.9	Critical spares	A list of critical spares which should be available, including specifications thereof. This is typically supplied as part of the capital investment
R.10	start–up consumables	Has the material and consumables which is required for start–up been addressed by the project team?
R.11	Operational systems and procedures to support each department	Has the project addressed the requirements of operational systems and created procedures to support the various operational departments?
R.12	Environmental Management Plan for Operations (EMP)	Is an EMP in place for post–completion of the project?

8.6 Annexure F – Email sent to participants to request assistance

Thank you very much for your willingness to assist with my studies.

As a general introduction if you are not familiar with the RAT, some background:

- I am busy with a PhD in Project Management. As part of the research, I am busy developing a Readiness Assessment Tool (RAT) for mining projects. A RAT is a tool which can be used to evaluate the level of scope development (completeness of a project study) at the end of the feasibility study, before the start of detail design and implementation.
- There are 4 such tools in existence, but not for mining projects. The tools were all developed by the Construction Industry Institute (CII)
- There are 2 parts to this phase of the research
  - In part 1 the participants will help to assign weights to an unweighted RAT check sheet.
  - In part 2, participants will provide information regarding a recently completed project, to validate the weighted tool which was developed in part 1.

I have attached a spreadsheet with several tabs.

1. The first tab deals with the participant's background – please complete this for each participant
2. The second tab is the sheet which will be used to assign weights to the various elements. Please complete this as described in the "Instructions to complete" section
3. The 3rd and 4th tab will be used to validate the RAT instrument, once completed. Please fill in the information regarding a recently completed project on the 3rd tab
4. Please complete the 4th tab as per the example, keeping the recently completed project in mind.
5. Tab 5 contains an "Informed Consent" form which you must please complete and sign.

8.7 Annexure G – List of Individual contributions, before normalization

SECTION I – BASIS OF PROJECT DECISION		Individual Contributions prior to Normalisation																			
CATEGORY Element		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
A	PROJECT STRATEGY																				
A.1	Project Justification	2%	8%	2%	10%	5%	20%	7%	25%	0%	1%	5%	25%	1%	25%	5%	25%	2%	8%	3%	12%
A.2	Project Charter and Mandate	4%	9%	2%	5%	5%	15%	7%	25%	0%	1%	2%	10%	2%	20%	5%	25%	3%	9%	2%	12%
A.3	Governance and control (internal approval process defined)	5%	10%	2%	7%	5%	10%	5%	20%	0%	1%	2%	25%	1%	5%	5%	25%	5%	10%	2%	10%
A.5	Project Strategy	2%	6%	2%	5%	8%	10%	5%	30%	0%	1%	1%	5%	1%	10%	5%	25%	6%	12%	3%	8%
A.6	Strategic fit of project in organisation	1%	6%	1%	10%	8%	5%	5%	25%	1%	1%	1%	5%	1%	15%	5%	25%	4%	8%	2%	8%
A.7	Due diligence	2%	7%	2%	10%	6%	5%	5%	25%	0%	1%	10%	25%	1%	20%	5%	25%	4%	8%	3%	8%
A.8	Partnership, joint ventures, and shareholder buy in	5%	10%	2%	5%	6%	20%	5%	30%	1%	5%	1%	10%	1%	25%	5%	25%	5%	11%	3%	8%
B	COUNTRY RISK																				
B.1	Social Issues	1%	7%	2%	4%	5%	10%	5%	35%	1%	5%	5%	25%	2%	20%	10%	30%	2%	6%	4%	15%
B.2	Geo–political risks	2%	7%	2%	4%	5%	10%	5%	35%	1%	3%	2%	15%	3%	30%	10%	30%	2%	6%	4%	6%
B.3	Fiscal stability agreement	3%	8%	2%	5%	8%	10%	5%	35%	1%	3%	2%	5%	3%	20%	10%	50%	1%	2%	2%	5%
B.4	Social License to Operate	2%	8%	2%	4%	5%	10%	5%	35%	1%	10%	10%	35%	2%	15%	10%	50%	3%	6%	4%	15%
B.5	Violence and terrorism	3%	8%	2%	4%	5%	10%	5%	50%	1%	2%	2%	2%	2%	25%	10%	50%	1%	2%	2%	6%
B.6	Ability to appoint expatriates	5%	10%	1%	5%	8%	10%	5%	35%	1%	2%	1%	1%	5%	30%	10%	30%	1%	2%	2%	7%
B.7	Procurement of local and foreign materials, services, and equipment	5%	10%	2%	10%	8%	10%	5%	40%	0%	3%	1%	10%	5%	30%	10%	25%	3%	6%	2%	10%
B.8	Country infrastructure (power, roads, rail, water ports)	4%	9%	2%	10%	5%	10%	5%	35%	0%	5%	1%	15%	5%	20%	10%	50%	4%	8%	2%	15%

Annexure G (Continued) – List of Individual contributions, before normalization

B.9	Custom duties & logistic routes	4%	10%	2%	5%	6%	10%	5%	35%	1%	3%	1%	5%	5%	25%	10%	50%	0%	1%	2%	10%
C	**PROJECT FEASIBILITY**																				
C.1	Resources secured (including land and mineral rights)	1%	10%	2%	10%	10%	20%	5%	35%	0%	5%	2%	35%	5%	30%	10%	50%	2%	6%	1%	50%
C.2	Financing secured (Internal, external, equity, debt)	2%	9%	1%	5%	10%	20%	5%	35%	0%	5%	1%	10%	2%	15%	10%	50%	4%	8%	1%	50%
C.3	Business Plan	3%	7%	1%	10%	8%	15%	5%	35%	0%	2%	5%	25%	2%	30%	10%	50%	2%	4%	2%	20%
C.4	Economic Analysis	4%	10%	1%	10%	8%	10%	5%	35%	0%	2%	5%	25%	2%	20%	10%	30%	1%	2%	5%	15%
C.5	Affordability / Feasibility	3%	7%	1%	10%	10%	20%	5%	35%	0%	3%	5%	25%	2%	30%	10%	50%	3%	6%	5%	25%
C.6	Contingencies (Capex & Opex)	5%	10%	5%	20%	5%	10%	5%	25%	3%	35%	10%	35%	5%	30%	10%	25%	2%	4%	3%	20%
C.7	Basis of Estimate	3%	8%	2%	7%	5%	10%	5%	25%	2%	5%	10%	35%	5%	35%	10%	20%	2%	4%	3%	15%
C.8	Scenario planning	2%	7%	1%	2%	8%	10%	5%	25%	2%	5%	5%	15%	5%	20%	10%	35%	1%	2%	2%	10%
D	**RESOURCE AND RESERVE STATEMENT**																				
D.1	Metallurgical yield	4%	8%	1%	5%	10%	20%	5%	35%	3%	30%			5%	35%	5%	50%	3%	6%	5%	20%
D.2	Reserve risks (including modifying factors)	4%	10%	1%	5%	10%	20%	5%	25%	15%	50%			5%	30%	5%	50%	4%	8%	5%	30%
D.3	Grade engineering / control	4%	9%	1%	5%	5%	10%	5%	25%	5%	15%			5%	15%	5%	30%	2%	4%	3%	10%
D.4	Prospect drilling standard / guideline	3%	8%	1%	7%	10%	15%	5%	25%	3%	5%			5%	10%	5%	30%	1%	2%	2%	15%
D.5	Geological conditions (Geological model, structure, qualities)	3%	10%	1%	5%	10%	10%	5%	25%	5%	25%			5%	20%	5%	50%	4%	8%	5%	40%
D.6	Hydrogeology	2%	8%	1%	5%	10%	10%	5%	25%	5%	10%			2%	7%	5%	30%	1%	2%	5%	15%
E	**LIFE OF MINE PLANNING**																				
E.1	Mine design criteria	3%	10%	1%	7%	8%	10%	5%	25%	1%	5%	2%	15%	5%	20%	10%	30%	2%	4%	2%	25%

Annexure G (Continued) – List of Individual contributions, before normalization

E	**LIFE OF MINE PLANNING**																				
E.2	Shaft/ramp design & men and material logistics	3%	10%	2%	5%	8%	5%	5%	25%	0%	1%	2%	15%	5%	15%	10%	30%	2%	4%	2%	25%
E.3	Mining methods (drilling, blasting, loading, hauling)	2%	8%	2%	5%	5%	10%	5%	25%	0%	5%	5%	20%	2%	10%	10%	30%	2%	4%	2%	25%
E.4	Equipment selection to fit geological conditions and mining method	2%	8%	2%	5%	8%	5%	5%	25%	1%	5%	5%	20%	5%	20%	10%	30%	2%	4%	2%	20%
E.5	Life–of–mine plan	4%	9%	2%	7%	10%	20%	5%	25%	0%	10%	10%	35%	2%	10%	10%	50%	3%	6%	1%	15%
E.6	Waste management plan	2%	7%	1%	5%	8%	5%	5%	25%	0%	1%	10%	35%	2%	10%	10%	30%	2%	4%	1%	15%
E.7	Ultimate pit limits designed	2%	7%	1%	5%	10%	10%	5%	25%	3%	10%	2%	15%	2%	5%	10%	30%	2%	4%	1%	15%
E.8	Economic block values determination	3%	9%	1%	3%	8%	10%	5%	25%	3%	25%	10%	35%	2%	30%	10%	50%	2%	4%	2%	15%
E.9	Beneficiation facilities LOM plan	4%	8%	2%	5%	8%	10%	5%	25%	3%	12%	5%	20%	2%	30%	10%	50%	2%	4%	2%	10%
E.10	Materials handling LOM plan	4%	8%	2%	5%	8%	10%	5%	25%	1%	3%	5%	20%	2%	30%	10%	50%	1%	2%	2%	10%
F	**OPERATING PHILOSOPHY**																				
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	3%	10%	2%	4%	8%	10%	5%	20%	0%	5%	1%	5%	2%	10%	5%	20%	3%	6%	2%	8%
F.2	Productivity / efficiency benchmarks	2%	9%	2%	5%	5%	5%	5%	20%	1%	3%	1%	1%	2%	5%	5%	15%	3%	6%	2%	6%
F.3	Operating costs	2%	7%	1%	7%	10%	10%	5%	30%	10%	35%	5%	15%	2%	20%	5%	50%	3%	6%	2%	10%
F.4	Production risks	2%	7%	1%	7%	5%	8%	5%	30%	5%	35%	1%	15%	5%	25%	10%	30%	3%	6%	2%	10%
F.5	Catalogue of operating plans	3%	8%	1%	5%	5%	5%	5%	20%	1%	5%	1%	1%	5%	20%	10%	20%	1%	2%	1%	5%
F.6	Haul roads	2%	8%	1%	4%	5%	10%	5%	25%	1%	4%	1%	5%	5%	10%	10%	35%	2%	4%	2%	7%
F.7	Transportation strategy	2%	9%	1%	4%	5%	8%	5%	25%	4%	15%	2%	10%	5%	10%	10%	20%	2%	4%	1%	8%
F.8	Contractual considerations	2%	10%	1%	4%	5%	8%	5%	20%	1%	8%	2%	10%	5%	20%	5%	10%	2%	4%	2%	6%

Annexure G (Continued) – List of Individual contributions, before normalization

G	**MARKET ANALYSIS AND STRATEGY**																				
G.1	Market Strategy & Sales Agreements	2%	8%	1%	5%	10%	10%	5%	25%	1%	10%	10%	35%	5%	30%	10%	50%	4%	8%	5%	15%
G.2	Price risks	4%	10%	2%	7%	8%	8%	5%	30%	5%	35%	10%	35%	5%	25%	10%	50%	5%	10%	5%	10%
G.3	Demand risks & replacement products / technologies	3%	9%	3%	7%	8%	8%	5%	30%	5%	25%	10%	35%	5%	30%	10%	50%	3%	6%	2%	10%
G.4	Value–Analysis Process	3%	7%	1%	5%	8%	8%	5%	25%	3%	15%	5%	20%	3%	5%	10%	35%	2%	4%	2%	15%
G.5	Hedging	2%	7%	1%	3%	5%	5%	5%	25%	3%	15%	2%	10%	3%	7%	10%	30%	1%	2%	2%	5%
G.6	Competitor analysis	3%	7%	1%	3%	5%	5%	5%	20%	1%	8%	1%	5%	2%	5%	10%	30%	3%	6%	2%	6%

SECTION I – BASIS OF PROJECT DECISION		Individual Contributions prior to Normalisation																	
	CATEGORY Element	P11		P12		P13		P14		P15		P16		P17		P18		P19	
A	**PROJECT STRATEGY**																		
A.1	Project Justification	5%	10%	5%	15%	2%	5%	0%	3%	1%	10%	2%	20%	0%	50%	2%	15%	2%	5%
A.2	Project Charter and Mandate	3%	10%	5%	10%	1%	2%	0%	3%	2%	20%	2%	10%	0%	20%	5%	10%	5%	10%
A.3	Governance and control (internal approval process defined)	3%	15%	5%	25%	1%	2%	0%	4%	2%	20%	5%	15%	0%	20%	5%	15%	5%	10%
A.5	Project Strategy	5%	10%	5%	10%	3%	7%	0%	2%	1%	30%	5%	15%	0%	30%	2%	8%	1%	5%
A.6	Strategic fit of project in organisation	1%	15%	0%	5%	1%	3%	0%	2%	1%	15%	2%	30%	2%	30%	2%	5%	1%	7%
A.7	Due diligence	2%	20%	5%	20%	2%	4%	0%	2%	1%	10%	2%	20%	0%	50%	2%	5%	3%	8%
A.8	Partnership, joint ventures, and shareholder buy in	1%	5%	5%	10%	2%	4%	0%	2%	5%	30%	3%	10%	2%	20%	2%	5%	7%	12%
B	**COUNTRY RISK**																		
B.1	Social Issues	15%	20%	10%	30%	1%	5%	5%	5%	5%	40%	1%	10%	5%	5%	5%	15%	5%	12%
B.2	Geo–political risks	4%	11%	5%	30%	1%	2%	5%	5%	3%	30%	1%	10%	2%	5%	5%	8%	4%	9%

Annexure G (Continued) – List of Individual contributions, before normalization

B	**COUNTRY RISK**																		
B.3	Fiscal stability agreement	2%	8%	0%	8%	1%	2%	5%	5%	1%	20%	2%	8%	2%	5%	2%	8%	6%	8%
B.4	Social License to Operate	5%	10%	0%	10%	1%	2%	5%	5%	5%	20%	3%	15%	2%	5%	2%	5%	2%	5%
B.5	Violence and terrorism	2%	8%	10%	30%	1%	1%	5%	5%	5%	50%	1%	5%	1%	5%	2%	5%	3%	5%
B.6	Ability to appoint expatriates	2%	6%	15%	35%	1%	3%	2%	2%	10%	30%	1%	5%	5%	5%	2%	6%	5%	11%
B.7	Procurement of local and foreign materials, services, and equipment	10%	20%	10%	25%	1%	2%	2%	2%	1%	10%	5%	15%	2%	5%	2%	5%	4%	7%
B.8	Country infrastructure (power, roads, rail, water ports)	3%	10%	10%	20%	1%	2%	5%	2%	2%	10%	3%	10%	2%	5%	2%	8%	5%	11%
B.9	Custom duties & logistic routes	2%	20%	10%	25%	1%	3%	2%	3%	5%	20%	3%	10%	1%	5%	2%	7%	3%	7%
C	**PROJECT FEASIBILITY**																		
C.1	Resources secured (including land and mineral rights)	1%	10%	0%	20%	1%	4%	2%	5%	1%	10%	5%	20%	0%	50%	1%	5%	4%	11%
C.2	Financing secured (Internal, external, equity, debt)	3%	11%	0%	5%	1%	5%	2%	5%	3%	25%	5%	15%	7%	50%	1%	4%	3%	7%
C.3	Business Plan	2%	9%	0%	10%	2%	4%	2%	4%	2%	20%	2%	15%	1%	5%	1%	5%	1%	5%
C.4	Economic Analysis	2%	10%	5%	15%	2%	3%	2%	5%	5%	30%	1%	15%	2%	30%	1%	5%	2%	7%
C.5	Affordability / Feasibility	2%	10%	0%	1%	1%	3%	2%	5%	1%	15%	1%	15%	5%	40%	1%	5%	3%	6%
C.6	Contingencies (Capex & Opex)	1%	10%	10%	20%	5%	15%	8%	15%	5%	20%	10%	30%	7%	30%	5%	15%	5%	10%
C.7	Basis of Estimate	1%	11%	5%	10%	1%	2%	2%	5%	1%	25%	5%	25%	7%	50%	2%	5%	4%	9%
C.8	Scenario planning	2%	12%	0%	15%	2%	6%	0%	2%	5%	10%	5%	20%	0%	25%	2%	4%	3%	5%
D	**RESOURCE AND RESERVE STATEMENT**																		
D.1	Metallurgical yield	1%	15%	0%	5%	1%	2%	2%	5%	1%	5%	10%	50%	2%	50%	5%	15%	3%	9%
D.2	Reserve risks (including modifying factors)	3%	16%	0%	5%	1%	2%	5%	10%	2%	10%	10%	50%	1%	50%	2%	15%	2%	5%

Annexure G (Continued) – List of Individual contributions, before normalization

D	**RESOURCE AND RESERVE STATEMENT**																		
D.3	Grade engineering / control	4%	14%	0%	5%	1%	2%	5%	10%	1%	5%	10%	50%	2%	50%	2%	10%	3%	7%
D.4	Prospect drilling standard / guideline	2%	13%	0%	15%	1%	2%	2%	2%	2%	15%	5%	40%	1%	30%	2%	10%	2%	10%
D.5	Geological conditions (Geological model, structure, qualities)	4%	16%	0%	15%	1%	2%	5%	10%	5%	20%	10%	40%	5%	50%	2%	5%	4%	11%
D.6	Hydrogeology	5%	15%	5%	15%	1%	2%	2%	5%	5%	20%	5%	25%	1%	25%	2%	8%	5%	8%
E	**LIFE OF MINE PLANNING**																		
E.1	Mine design criteria	2%	14%	5%	10%	1%	2%	2%	4%	2%	10%	5%	25%	1%	50%	5%	10%	3%	9%
E.2	Shaft/ramp design & men and material logistics	2%	16%	5%	25%	1%	2%	2%	4%	2%	15%	5%	15%	1%	50%	2%	5%	4%	10%
E.3	Mining methods (drilling, blasting, loading, hauling)	2%	14%	0%	5%	1%	2%	2%	4%	1%	20%	5%	30%	1%	50%	2%	5%	1%	5%
E.4	Equipment selection to fit geological conditions and mining method	1%	9%	0%	5%	1%	2%	2%	4%	1%	5%	5%	30%	1%	50%	2%	5%	2%	7%
E.5	Life–of–mine plan	1%	5%	0%	5%	1%	2%	1%	2%	1%	15%	5%	25%	1%	25%	2%	4%	3%	7%
E.6	Waste management plan	3%	12%	5%	20%	1%	2%	1%	2%	3%	10%	5%	25%	1%	5%	2%	4%	2%	4%
E.7	Ultimate pit limits designed	1%	8%	0%	5%	1%	2%	1%	2%	1%	5%	5%	25%	5%	50%	2%	10%	3%	5%
E.8	Economic block values determination	3%	12%	0%	5%	1%	2%	1%	5%	2%	10%	5%	25%	3%	30%	2%	10%	4%	7%
E.9	Beneficiation facilities LOM plan	3%	10%	5%	15%	1%	2%	1%	5%	2%	15%	5%	25%	2%	25%	2%	8%	2%	4%
E.10	Materials handling LOM plan	3%	10%	5%	20%	1%	2%	1%	2%	5%	20%	5%	20%	1%	25%	2%	5%	5%	8%
F	**OPERATING PHILOSOPHY**																		
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	2%	8%	0%	5%	1%	2%	1%	2%	3%	10%	3%	15%	5%	40%	2%	5%	2%	9%

Annexure G (Continued) – List of Individual contributions, before normalization

F	**OPERATING PHILOSOPHY**																				
F.2	Productivity / efficiency benchmarks	3%	12%	2%	10%	2%	4%	0%	2%	2%	15%	4%	25%	1%	5%	5%	10%	2%	7%
F.3	Operating costs	3%	15%	5%	20%	1%	3%	2%	10%	1%	20%	4%	25%	5%	50%	5%	10%	4%	10%
F.4	Production risks	3%	15%	5%	20%	1%	2%	2%	5%	2%	15%	3%	20%	7%	50%	4%	10%	3%	6%
F.5	Catalogue of operating plans	1%	7%	5%	15%	1%	2%	0%	2%	2%	15%	2%	15%	1%	5%	4%	12%	4%	7%
F.6	Haul roads	2%	9%	0%	25%	1%	2%	1%	2%	1%	10%	2%	20%	0%	25%	1%	8%	3%	8%
F.7	Transportation strategy	3%	12%	5%	20%	1%	2%	0%	2%	1%	15%	2%	20%	2%	25%	1%	7%	1%	4%
F.8	Contractual considerations	4%	15%	5%	15%	2%	4%	0%	2%	5%	20%	2%	20%	2%	25%	2%	4%	2%	5%
G	**MARKET ANALYSIS AND STRATEGY**																				
G.1	Market Strategy & Sales Agreements	1%	8%	0%	5%	1%	2%	0%	5%	1%	5%	2%	25%	5%	35%	2%	10%	1%	3%
G.2	Price risks	3%	13%	0%	5%	1%	2%	5%	15%	2%	10%	5%	25%	10%	35%	2%	8%	3%	8%
G.3	Demand risks & replacement products / technologies	2%	15%	0%	5%	1%	2%	5%	10%	1%	5%	5%	15%	10%	50%	2%	10%	1%	3%
G.4	Value–Analysis Process	1%	7%	0%	5%	1%	2%	0%	3%	5%	15%	3%	15%	5%	35%	2%	6%	2%	4%
G.5	Hedging	1%	8%	0%	5%	1%	2%	0%	2%	1%	2%	2%	10%	5%	5%	4%	8%	3%	6%
G.6	Competitor analysis	1%	5%	0%	1%	1%	2%	0%	3%	5%	15%	2%	15%	2%	5%			2%	7%

SECTION II – PROJECT DETAILS		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
H	**PROJECT CONSIDERATIONS**																				
H.1	Expected Project Life Cycle	3%	10%	1%	5%	5%	5%	5%	35%	1%	5%	10%	25%	5%	30%						
H.2	Assumption register	2%	6%	1%	2%	5%	5%	5%	15%	3%	15%	2%	5%	5%	10%	10%	25%	1%	2%	1%	5%
H.3	Completion risks	3%	7%	3%	7%	5%	5%	5%	25%	5%	15%	2%	5%	5%	10%	10%	25%	2%	4%	1%	6%

Annexure G (Continued) – List of Individual contributions, before normalization

H	**PROJECT CONSIDERATIONS**																				
H.4	Project Design Criteria	2%	8%	2%	5%	10%	5%	5%	35%	1%	15%	2%	5%	5%	30%	10%	35%	1%	2%	2%	10%
H.5	Scope of Work Overview	2%	8%	1%	7%	8%	20%	5%	35%	3%	25%	2%	5%	5%	30%	10%	50%	3%	6%	2%	10%
H.6	Project Schedule	4%	10%	2%	10%	8%	20%	5%	35%	5%	25%	10%	25%	2%	25%	10%	35%	4%	8%	2%	10%
H.7	Project Cost Estimate	4%	10%	5%	20%	10%	20%	5%	25%	3%	35%	10%	25%	5%	25%	10%	35%	4%	8%	2%	10%
H.8	Investment Studies & Alternatives Assessments	2%	7%	1%	15%	8%	10%	5%	25%	1%	5%	2%	10%	5%	15%	10%	25%	2%	4%	1%	20%
H.9	Key Team Member Coordination	2%	7%	0%	2%	5%	10%	5%	25%	1%	4%	2%	10%	5%	15%	10%	25%	4%	8%	0%	6%
H.10	Evaluation of Compliance Requirements	2%	8%	1%	5%	5%	8%	5%	35%	1%	3%	5%	15%	3%	25%	10%	50%	3%	6%	2%	20%
H.11	Lead / Discipline Scope of Work	1%	8%	0%	2%	10%	15%	5%	25%	2%	5%	2%	5%	3%	25%	10%	25%	3%	6%	1%	6%
H.12	Housing and transport of employees	3%	10%	0%	3%	8%	10%	5%	25%	1%	4%	2%	5%	3%	15%	10%	25%	2%	4%	2%	8%
H.13	Risk or impact on other projects / divisions	2%	7%	0%	1%	8%	5%	5%	25%	1%	5%	2%	5%	3%	10%	10%	25%	2%	4%	2%	6%
I	**PROJECT SCOPE**																				
I.1	Project Objectives Statement	1%	7%	0%	3%	10%	10%	5%	30%	0%	3%	2%	10%	3%	35%	10%	25%	3%	6%	0%	8%
I.2	Site Characteristics Available vs. Required	2%	7%	1%	3%	5%	5%	5%	25%	1%	5%	2%	10%	3%	30%	10%	25%	2%	4%	2%	5%
I.3	Project Scope Definition	2%	9%	1%	5%	10%	15%	5%	35%	3%	20%	10%	25%	3%	35%	10%	25%	3%	6%	2%	10%
I.4	WBS and WBS Dictionary	2%	8%	2%	5%	8%	10%	5%	25%	1%	10%	10%	25%	3%	35%	10%	25%	2%	4%	2%	10%
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																				
J.1	Unique mine closure plan	1%	7%	0%	5%	5%	10%	5%	25%	1%	3%	1%	5%	2%	10%	10%	20%	2%	4%	1%	5%
J.2	Land use plan post operations	1%	7%	1%	3%	5%	8%	5%	20%	1%	3%	1%	5%	2%	5%	10%	20%	1%	2%	1%	5%
J.3	Social expectations register	2%	7%	1%	3%	5%	8%	5%	30%	2%	5%	1%	5%	2%	8%	10%	20%	2%	4%	1%	5%
J.4	Relocation Action Plan	2%	9%	2%	5%	8%	8%	5%	40%	2%	5%	10%	35%	2%	30%	10%	20%	3%	6%	2%	10%

Annexure G (Continued) – List of Individual contributions, before normalization

J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																				
J.5	Environmental expectations register	1%	8%	1%	5%	5%	5%	5%	25%	2%	8%	5%	15%	2%	20%	10%	20%	2%	4%	1%	10%
J.6	Political expectations register	2%	10%	1%	3%	5%	5%	5%	25%	3%	8%	1%	5%	2%	8%	10%	20%	4%	8%	1%	6%
J.7	Legal compliance register	2%	8%	2%	7%	10%	10%	5%	25%	1%	4%	10%	35%	2%	25%	10%	30%	3%	6%	1%	8%
J.8	HSE risk register	3%	8%	2%	5%	5%	5%	5%	20%	0%	3%	1%	5%	5%	18%	10%	30%	2%	4%	2%	10%
J.9	Community risk register	2%	7%	2%	5%	5%	5%	5%	25%	3%	8%	2%	10%	2%	15%	10%	30%	4%	8%	2%	6%
J.10	Business risk register	2%	7%	1%	5%	8%	5%	5%	25%	2%	8%	1%	5%	2%	20%	10%	30%	2%	4%	1%	7%
J.11	Developmental opportunity register	2%	7%	0%	3%	5%	5%	5%	25%	1%	3%	1%	5%	5%	10%	10%	20%	1%	2%	0%	3%
J.12	Sustainability operating plan	2%	7%	0%	3%	5%	10%	5%	25%	1%	3%	1%	5%	5%	10%	10%	25%	2%	4%	1%	6%
J.13	Stakeholder engagement plan	4%	9%	1%	3%	10%	10%	5%	25%	3%	5%	1%	5%	2%	10%	10%	25%	2%	4%	0%	7%
J.14	Mine closure financial provision plan	5%	9%	2%	5%	10%	10%	5%	25%	3%	15%	1%	5%	1%	10%	10%	30%	1%	2%	0%	4%
J.15	Closure plan review and updates scheduled during Life of Mine plan	2%	8%	1%	3%	5%	10%	5%	20%	1%	10%	1%	5%	2%	10%	5%	30%	1%	2%	0%	4%
J.16	Social investment plan	3%	7%	0%	2%	5%	10%	5%	30%	1%	3%	1%	5%	2%	8%	5%	20%	2%	4%	0%	6%
J.17	Economic diversification plan	2%	7%	0%	2%	5%	10%	5%	25%	1%	2%	1%	5%	1%	5%	5%	20%	2%	4%	0%	4%
J.18	Existing Environmental Conditions	1%	8%	1%	5%	5%	10%	5%	25%	2%	7%	1%	5%	1%	5%	5%	20%	1%	2%	1%	5%
J.19	Environmental Process determined	2%	7%	1%	5%	5%	10%	5%	25%	1%	8%	1%	5%	2%	8%	5%	20%	2%	4%	1%	6%
J.20	Environmental management plan	1%	7%	2%	5%	5%	10%	5%	25%	3%	12%	1%	5%	1%	5%	5%	20%	2%	4%	1%	6%

Annexure G (Continued) – List of Individual contributions, before normalization

SECTION II – PROJECT DETAILS		P11		P12		P13		P14		P15		P16		P17		P18		P19	
H	**PROJECT CONSIDERATIONS**																		
H.1	Expected Project Life Cycle	1%	6%	5%	20%	3%	7%	1%	2%	5%	20%	5%	30%	5%	5%	0%	5%	3%	6%
H.2	Assumption register	1%	3%	1%	15%	2%	5%	1%	2%	2%	15%	2%	10%	3%	35%	5%	10%	4%	7%
H.3	Completion risks	1%	4%	5%	20%	3%	6%	1%	2%	5%	25%	2%	15%	10%	35%	5%	5%	2%	9%
H.4	Project Design Criteria	1%	5%	5%	25%	2%	4%	1%	2%	2%	30%	2%	25%	1%	35%	2%	10%	3%	11%
H.5	Scope of Work Overview	1%	10%	5%	30%	2%	5%	5%	10%	5%	30%	5%	30%	2%	35%	2%	15%	3%	10%
H.6	Project Schedule	1%	10%	5%	30%	4%	10%	2%	10%	5%	45%	5%	30%	5%	35%	2%	15%	2%	8%
H.7	Project Cost Estimate	1%	10%	5%	35%	5%	8%	5%	15%	5%	50%	5%	30%	5%	35%	10%	15%	0%	7%
H.8	Investment Studies & Alternatives Assessments	1%	8%	0%	10%	2%	4%	1%	4%	5%	15%	5%	25%	2%	35%	2%	8%	1%	4%
H.9	Key Team Member Coordination	1%	4%	5%	20%	1%	2%	0%	2%	2%	10%	5%	15%	7%	35%	2%	5%	1%	5%
H.10	Evaluation of Compliance Requirements	1%	3%	5%	30%	1%	2%	0%	2%	5%	20%	5%	25%	3%	35%	2%	5%	2%	4%
H.11	Lead / Discipline Scope of Work	1%	3%	5%	25%	2%	3%	2%	5%	2%	30%	5%	25%	2%	35%	5%	10%	3%	6%
H.12	Housing and transport of employees	1%	3%	5%	10%	1%	2%	2%	3%	1%	5%	2%	10%	1%	35%	2%	5%	2%	7%
H.13	Risk or impact on other projects / divisions	1%	5%	5%	10%	1%	2%	1%	2%	1%	5%	2%	10%	1%	35%	2%	8%	3%	10%
I	**PROJECT SCOPE**																		
I.1	Project Objectives Statement	1%	5%	0%	5%	1%	2%	0%	3%	2%	10%	2%	25%	1%	50%	2%	10%	1%	3%
I.2	Site Characteristics Available vs. Required	1%	6%	5%	7%	1%	2%	1%	2%	1%	25%	2%	20%	3%	35%	2%	10%	3%	5%
I.3	Project Scope Definition	1%	8%	5%	30%	2%	4%	2%	10%	5%	30%	5%	25%	2%	40%	5%	15%	2%	7%
I.4	WBS and WBS Dictionary	1%	10%	2%	30%	2%	4%	0%	5%	2%	40%	5%	25%	1%	35%	2%	15%	4%	6%

Annexure G (Continued) – List of Individual contributions, before normalization

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS																		
J.1	Unique mine closure plan	5%	15%	1%	10%	1%	2%	2%	5%	5%	30%	2%	8%	1%	20%	0%	5%	3%	7%
J.2	Land use plan post operations	5%	15%	0%	5%	1%	2%	1%	2%	5%	50%	2%	8%	1%	20%	2%	5%	4%	6%
J.3	Social expectations register	5%	20%	5%	15%	1%	2%	0%	2%	1%	20%	3%	10%	1%	20%	2%	5%	3%	7%
J.4	Relocation Action Plan	15%	30%	10%	30%	1%	2%	2%	5%	2%	20%	3%	10%	1%	20%	2%	8%	2%	5%
J.5	Environmental expectations register	5%	13%	5%	15%	1%	2%	0%	3%	5%	15%	3%	15%	1%	20%	2%	5%	0%	3%
J.6	Political expectations register	5%	15%	5%	20%	1%	2%	0%	2%	2%	20%	1%	10%	1%	20%	2%	5%	1%	4%
J.7	Legal compliance register	4%	12%	5%	15%	1%	2%	0%	5%	1%	20%	1%	10%	1%	20%	2%	8%	4%	8%
J.8	HSE risk register	2%	8%	5%	10%	1%	2%	0%	5%	1%	20%	3%	15%	1%	20%	2%	8%	2%	4%
J.9	Community risk register	10%	20%	1%	15%	1%	2%	0%	5%	5%	25%	3%	10%	1%	20%	2%	8%	3%	8%
J.10	Business risk register	1%	7%	0%	10%	1%	2%	0%	5%	1%	15%	3%	15%	1%	20%	2%	8%	4%	5%
J.11	Developmental opportunity register	4%	14%	5%	20%	1%	2%	0%	5%	1%	10%	3%	15%	1%	20%	2%	5%	3%	6%
J.12	Sustainability operating plan	1%	8%	5%	15%	1%	2%	0%	5%	1%	20%	3%	10%	1%	20%	2%	5%	2%	4%
J.13	Stakeholder engagement plan	5%	16%	2%	10%	1%	2%	0%	5%	1%	20%	2%	10%	1%	20%	2%	10%	1%	4%
J.14	Mine closure financial provision plan	4%	15%	5%	30%	1%	2%	0%	5%	1%	5%	2%	15%	1%	20%	2%	5%	2%	9%
J.15	Closure plan review and updates scheduled during Life of Mine plan	1%	9%	0%	10%	1%	2%	0%	5%	2%	10%	2%	10%	1%	20%	2%	8%	2%	4%
J.16	Social investment plan	5%	14%	5%	30%	1%	2%	0%	5%	1%	20%	2%	10%	1%	20%	2%	5%	3%	6%
J.17	Economic diversification plan	3%	10%	5%	30%	1%	2%	0%	5%	1%	15%	2%	10%	1%	20%	2%	5%	3%	5%
J.18	Existing Environmental Conditions	1%	8%	2%	15%	1%	2%	0%	5%	1%	20%	2%	15%	1%	20%	2%	5%	4%	6%
J.19	Environmental Process determined	1%	10%	2%	10%	1%	2%	0%	5%	1%	15%	2%	15%	1%	20%	2%	5%	3%	6%
J.20	Environmental management plan	2%	12%	5%	25%	1%	2%	0%	5%	5%	60%	2%	15%	1%	20%	2%	8%	2%	4%

Annexure G (Continued) – List of Individual contributions, before normalization

SECTION III – DESIGN FOR CONSTRUCTION		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
K	**SITE INFORMATION**																				
K.1	Site Layout	2%	8%	2%	7%	5%	5%	5%	25%	1%	5%	2%	15%	1%	10%	10%	50%	1%	2%	1%	5%
K.2	Site Surveys	2%	8%	1%	5%	5%	5%	5%	25%	1%	5%	2%	15%	1%	5%	10%	50%	1%	2%	1%	5%
K.3	Governing Regulatory Requirements	4%	10%	0%	2%	10%	10%	5%	35%	0%	5%	1%	25%	1%	20%	10%	30%	2%	4%	1%	5%
K.4	Utility Sources with Supply Conditions	2%	9%	2%	5%	5%	5%	5%	30%	2%	5%	2%	20%	2%	25%	10%	25%	1%	2%	1%	5%
K.5	Fire Protection, emergency procedure & Safety Considerations	1%	6%	1%	5%	10%	10%	5%	25%	1%	5%	1%	5%	2%	10%	10%	20%	1%	2%	1%	4%
K.6	Special Water and Waste Treatment Requirements	2%	7%	2%	6%	5%	5%	5%	25%	1%	5%	1%	5%	2%	10%	10%	25%	2%	4%	1%	4%
K.7	Property Descriptions	1%	6%	1%	2%	5%	5%	5%	20%	2%	5%	1%	2%	2%	8%	10%	20%	1%	2%	0%	3%
K.8	Right–of–Way Mapping & Site Issues	2%	7%	1%	4%	5%	5%	5%	25%	1%	6%	1%	2%	2%	8%	10%	30%	1%	2%	1%	5%
K.9	Land Rights	3%	10%	3%	7%	10%	10%	5%	35%	3%	9%	1%	20%	2%	15%	10%	50%	3%	6%	0%	6%
L	**PROJECT DESIGN PARAMETERS**																				
L.1	Design Criteria	2%	8%	3%	7%	8%	10%	5%	35%	1%	3%	1%	3%	2%	10%	5%	30%	1%	2%	1%	8%
L.2	Civil/Site Design	2%	7%	5%	10%	8%	10%	5%	25%	2%	8%	1%	3%	2%	15%	5%	30%	2%	4%	1%	6%
L.3	Geotechnical investigation for structures	1%	7%	5%	10%	5%	7%	5%	25%	1%	5%	5%	25%	2%	15%	5%	30%	2%	4%	1%	10%
L.4	Architectural Design	1%	6%	2%	5%	5%	7%	5%	20%	0%	3%	1%	3%	2%	10%	5%	30%	1%	2%	1%	6%
L.5	Structural Design	2%	7%	3%	6%	8%	10%	5%	30%	2%	6%	1%	3%	2%	20%	5%	30%	2%	4%	1%	6%
L.6	Mechanical Design	2%	7%	3%	6%	8%	10%	5%	30%	2%	8%	1%	3%	2%	20%	5%	30%	2%	4%	1%	6%
L.7	Electrical Design	2%	7%	4%	8%	8%	10%	5%	30%	1%	5%	1%	3%	2%	15%	5%	30%	2%	4%	1%	6%
L.8	Constructability Analysis	3%	8%	5%	10%	5%	6%	5%	30%	2%	10%	1%	3%	3%	25%	5%	30%	2%	4%	1%	6%
L.9	Process Design	2%	10%	5%	15%	10%	10%	5%	25%	3%	15%	5%	25%	5%	30%	5%	30%	3%	6%	1%	10%

Annexure G (Continued) – List of Individual contributions, before normalization

L	**PROJECT DESIGN PARAMETERS**																				
L.10	Specifications	2%	8%	2%	7%	8%	10%	5%	25%	1%	5%	1%	3%	1%	8%	5%	30%	2%	4%	1%	6%
L.11	Specialty Items List	1%	6%	1%	3%	5%	5%	5%	25%	0%	2%	1%	3%	3%	10%	5%	30%	1%	2%	1%	6%
L.12	Instrument Index	2%	7%	5%	10%	8%	10%	5%	25%	0%	3%	1%	3%	3%	8%	5%	30%	0%	1%	1%	5%
L.13	Control Philosophy & systems	2%	7%	3%	8%	8%	10%	5%	25%	1%	5%	1%	3%	1%	8%	5%	30%	3%	6%	1%	5%
L.14	Logic Diagrams	2%	7%	3%	8%	8%	10%	5%	25%	0%	2%	1%	3%	1%	8%	5%	30%	1%	2%	1%	5%
L.15	IM (information management)	2%	7%	2%	5%	8%	10%	5%	25%	1%	3%	1%	3%	3%	15%	5%	30%	1%	2%	1%	5%
L.16	Control of Access	1%	6%	1%	5%	5%	10%	5%	25%	0%	1%	1%	3%	2%	10%	5%	30%	1%	2%	1%	4%
L.17	Safety & Hazards	1%	6%	4%	10%	10%	10%	5%	25%	1%	2%	1%	3%	2%	10%	5%	30%	2%	4%	1%	6%
L.18	Operations/Maintenance	1%	6%	2%	5%	5%	10%	5%	25%	2%	6%	1%	3%	2%	8%	5%	30%	2%	4%	1%	6%
L.19	Ventilation Engineering	2%	8%	2%	5%	8%	8%	5%	25%	1%	3%	1%	3%	2%	10%	5%	30%	1%	2%	2%	20%
L.20	Rock Engineering	2%	8%	4%	10%	8%	8%	5%	25%	3%	8%	1%	3%	2%	10%	5%	30%	0%	1%	2%	20%
L.21	Water balances	2%	8%	2%	7%	8%	8%	5%	25%	2%	6%	5%	15%	2%	10%	5%	30%	2%	4%	1%	6%
L.22	Energy efficiency / carbon footprint	1%	6%	1%	5%	8%	8%	5%	25%	0%	2%	5%	15%	1%	5%	5%	30%	1%	2%	1%	5%
L.23	Tailings handling and storage	2%	8%	3%	10%	8%	8%	5%	25%	3%	9%	5%	15%	2%	10%	5%	30%	2%	4%	1%	15%
L.24	Stormwater handling / surface hydrology	2%	8%	3%	10%	8%	8%	5%	25%	2%	6%	5%	15%	1%	5%	5%	30%	1%	2%	1%	6%
L.25	Internal technical audits	1%	6%	1%	3%	5%	8%	5%	20%	0%	2%	1%	3%	1%	3%	5%	30%	3%	6%	0%	4%
L.26	External technical audits	1%	6%	1%	3%	5%	8%	5%	20%	0%	2%	1%	3%	1%	3%	5%	30%	1%	2%	0%	4%
M	**VALUE IMPROVING PRACTICES**																				
M.1	Process Simplification	2%	7%	2%	5%	5%	5%	5%	25%	0%	3%	1%	3%	2%	20%	5%	20%	1%	2%	0%	2%
M.2	Design & Material Alternatives Considered/Rejected	2%	7%	1%	4%	5%	5%	5%	20%	0%	3%	1%	3%	2%	10%	5%	15%	2%	4%	0%	2%
M.3	Technology trends	2%	7%	2%	5%	8%	8%	5%	20%	1%	3%	1%	3%	2%	8%	5%	15%	2%	4%	0%	2%
M.4	Design to capacity	2%	7%	2%	8%	10%	10%	5%	25%	1%	4%	1%	3%	2%	10%	5%	20%	2%	4%	0%	2%

Annexure G (Continued) – List of Individual contributions, before normalization

M	VALUE IMPROVING PRACTICES																				
M.5	Classes of facility quality	2%	7%	1%	3%	5%	5%	5%	25%	0%	2%	1%	3%	1%	10%	5%	15%	1%	2%	0%	4%
M.6	Energy optimisation	2%	6%	1%	3%	5%	5%	5%	20%	0%	2%	1%	3%	2%	8%	5%	15%	2%	4%	0%	2%
M.7	Waste minimisation	1%	6%	2%	4%	8%	8%	5%	20%	1%	5%	1%	3%	2%	10%	5%	25%	2%	4%	0%	2%
M.8	3D / 4D design	2%	6%	2%	8%	10%	10%	5%	25%	1%	3%	1%	3%	2%	20%	5%	10%	1%	2%	0%	2%
M.9	Cleaner Production	2%	7%	1%	3%	5%	5%	5%	25%	0%	2%	1%	3%	1%	10%	5%	15%	2%	4%	0%	2%
M.10	Innovation and knowledge management planning	2%	6%	1%	4%	8%	8%	5%	20%	0%	1%	1%	3%	2%	10%	5%	10%	1%	2%	0%	2%
M.11	Six Sigma	1%	6%	1%	4%	5%	5%	5%	25%	0%	1%	1%	3%	2%	10%	2%	5%	0%	1%	0%	2%
M.12	Lean Manufacturing	1%	6%	2%	5%	5%	5%	5%	20%	0%	1%	1%	3%	3%	8%	2%	5%	0%	1%	0%	2%

SECTION III – DESIGN FOR CONSTRUCTION		P11		P12		P13		P14		P15		P16		P17		P18		P19	
K	SITE INFORMATION																		
K.1	Site Layout	1%	5%	2%	10%	2%	3%	2%	5%	5%	20%	5%	25%	2%	40%	3%	8%	3%	5%
K.2	Site Surveys	1%	6%	5%	15%	2%	5%	2%	5%	2%	15%	3%	20%	2%	40%	1%	5%	2%	4%
K.3	Governing Regulatory Requirements	1%	6%	1%	5%	1%	2%	2%	5%	1%	15%	3%	20%	2%	40%	1%	8%	3%	6%
K.4	Utility Sources with Supply Conditions	1%	7%	1%	5%	1%	2%	2%	5%	1%	20%	3%	20%	5%	50%	2%	5%	3%	7%
K.5	Fire Protection, emergency procedure & Safety Considerations	1%	5%	5%	10%	1%	2%	2%	5%	1%	10%	3%	20%	1%	5%	2%	5%	4%	9%
K.6	Special Water and Waste Treatment Requirements	1%	5%	0%	5%	1%	2%	2%	5%	3%	15%	3%	20%	0%	50%	2%	5%	4%	7%
K.7	Property Descriptions	1%	3%	0%	0%	1%	2%	2%	5%	1%	10%	1%	10%	0%	5%	2%	4%	1%	4%
K.8	Right–of–Way Mapping & Site Issues	1%	4%	0%	2%	1%	2%	2%	5%	2%	10%	2%	20%	1%	50%	2%	5%	2%	3%
K.9	Land Rights	1%	8%	0%	5%	1%	2%	2%	5%	1%	15%	2%	20%	1%	50%	2%	10%	2%	5%

Annexure G (Continued) – List of Individual contributions, before normalization

L	PROJECT DESIGN PARAMETERS																		
L.1	Design Criteria	1%	10%	1%	15%	3%	5%	2%	5%	5%	15%	2%	25%	1%	35%	2%	8%	1%	4%
L.2	Civil/Site Design	1%	8%	1%	10%	3%	5%	2%	5%	5%	20%	2%	25%	1%	35%	2%	5%	2%	5%
L.3	Geotechnical investigation for structures	2%	13%	0%	5%	3%	5%	2%	5%	10%	30%	2%	25%	1%	35%	2%	5%	1%	6%
L.4	Architectural Design	1%	4%	0%	5%	3%	5%	1%	2%	10%	20%	2%	25%	1%	35%	2%	4%	3%	7%
L.5	Structural Design	1%	4%	5%	10%	3%	5%	2%	5%	10%	30%	2%	25%	1%	35%	2%	5%	2%	5%
L.6	Mechanical Design	1%	4%	5%	10%	3%	5%	2%	5%	5%	15%	2%	25%	1%	35%	2%	5%	3%	7%
L.7	Electrical Design	1%	4%	5%	10%	3%	5%	2%	5%	10%	40%	2%	25%	1%	35%	2%	5%	4%	9%
L.8	Constructability Analysis	3%	12%	5%	15%	3%	5%	2%	5%	10%	30%	3%	20%	1%	35%	2%	4%	3%	6%
L.9	Process Design	3%	14%	5%	20%	3%	5%	2%	5%	5%	20%	3%	20%	1%	35%	2%	10%	2%	7%
L.10	Specifications	1%	5%	0%	10%	3%	5%	2%	5%	10%	30%	2%	25%	1%	35%	2%	5%	3%	8%
L.11	Specialty Items List	1%	4%	2%	10%	3%	5%	2%	5%	10%	20%	2%	25%	1%	35%	2%	3%	3%	11%
L.12	Instrument Index	1%	8%	1%	5%	3%	5%	2%	5%	10%	20%	2%	15%	1%	35%	1%	3%	4%	8%
L.13	Control Philosophy & systems	1%	10%	0%	10%	3%	5%	2%	5%	10%	30%	2%	15%	1%	35%	1%	4%	5%	11%
L.14	Logic Diagrams	1%	8%	0%	5%	3%	5%	2%	5%	10%	30%	2%	15%	1%	35%	1%	3%	3%	8%
L.15	IM (information management)	1%	10%	0%	1%	3%	5%	2%	5%	5%	25%	2%	15%	1%	35%	1%	3%	3%	5%
L.16	Control of Access	1%	5%	0%	5%	3%	5%	2%	5%	2%	10%	2%	10%	1%	35%	0%	2%	3%	6%
L.17	Safety & Hazards	1%	10%	0%	5%	3%	5%	2%	5%	10%	30%	2%	15%	1%	35%	1%	3%	2%	6%
L.18	Operations/Maintenance	1%	7%	0%	5%	3%	5%	2%	5%	10%	40%	3%	20%	1%	35%	2%	8%	2%	9%
L.19	Ventilation Engineering	1%	8%	5%	10%	3%	5%	2%	5%	10%	20%	2%	15%	1%	35%	2%	8%	4%	9%
L.20	Rock Engineering	3%	12%	5%	10%	3%	5%	2%	5%	15%	40%	3%	20%	1%	35%	2%	6%	2%	5%
L.21	Water balances	1%	10%	0%	5%	3%	5%	2%	5%	10%	30%	3%	20%	1%	35%	2%	6%	2%	7%
L.22	Energy efficiency / carbon footprint	1%	5%	0%	1%	3%	5%	1%	2%	15%	40%	2%	10%	1%	35%	2%	5%	3%	6%
L.23	Tailings handling and storage	1%	6%	5%	15%	3%	5%	2%	8%	10%	30%	2%	10%	1%	35%	2%	5%	4%	10%

Annexure G (Continued) – List of Individual contributions, before normalization

L	**PROJECT DESIGN PARAMETERS**																		
L.24	Stormwater handling / surface hydrology	1%	5%	0%	10%	3%	5%	2%	5%	10%	25%	2%	10%	1%	35%	2%	4%	3%	7%
L.25	Internal technical audits	1%	6%	0%	1%	3%	5%	2%	5%	5%	15%	2%	10%	1%	35%	2%	2%	1%	3%
L.26	External technical audits	1%	6%	0%	1%	3%	5%	1%	2%	5%	20%	2%	15%	1%	35%	2%	2%	3%	7%
M	**VALUE IMPROVING PRACTICES**																		
M.1	Process Simplification	1%	8%	0%	5%	2%	5%	1%	2%	10%	40%	3%	25%	0%	0%	2%	4%	3%	6%
M.2	Design & Material Alternatives Considered/Rejected	1%	8%	1%	5%	2%	4%	1%	2%	15%	30%	3%	25%	1%	25%	2%	4%	2%	5%
M.3	Technology trends	1%	7%	0%	5%	1%	3%	1%	2%	10%	30%	3%	20%	2%	25%	2%	3%	4%	8%
M.4	Design to capacity	1%	8%	1%	5%	1%	2%	1%	2%	5%	15%	2%	15%	2%	25%	2%	4%	2%	4%
M.5	Classes of facility quality	1%	7%	5%	10%	1%	2%	1%	2%	5%	20%	4%	20%	0%	0%	0%	2%	0%	3%
M.6	Energy optimisation	1%	9%	5%	15%	1%	3%	1%	2%	10%	20%	4%	20%	0%	0%	0%	2%	2%	5%
M.7	Waste minimisation	1%	9%	0%	5%	1%	2%	1%	2%	10%	20%	3%	20%	0%	0%	0%	4%	2%	7%
M.8	3D / 4D design	1%	9%	0%	10%	3%	6%	1%	2%	10%	30%	2%	15%	0%	0%	0%	3%	1%	5%
M.9	Cleaner Production	1%	8%	5%	10%	2%	4%	1%	2%	5%	10%	2%	15%	0%	0%	0%	2%	3%	8%
M.10	Innovation and knowledge management planning	1%	10%	0%	5%	2%	5%	1%	2%	10%	30%	4%	15%	0%	0%	2%	4%	2%	4%
M.11	Six Sigma	2%	11%	0%	10%	2%	5%	1%	2%	15%	20%	2%	15%	0%	0%	2%	4%	2%	5%
M.12	Lean Manufacturing	1%	8%	0%	5%	2%	5%	1%	2%	10%	30%	2%	15%	0%	0%	1%	3%	1%	5%

Annexure G (Continued) – List of Individual contributions, before normalization

SECTION IV – IMPLEMENTATION APPROACH		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
N	**PROCUREMENT STRATEGY**																				
N.1	Identify Long Lead/Critical Equipment and Materials	3%	8%	1%	7%	8%	8%	5%	35%	2%	8%	5%	15%	1%	5%	5%	10%	3%	6%	1%	5%
N.2	Procurement Procedures and Plans	2%	8%	1%	5%	10%	10%	5%	25%	1%	6%	2%	10%	2%	5%	10%	15%	2%	4%	1%	5%
N.3	Procurement Responsibility Matrix	2%	7%	1%	5%	10%	10%	5%	30%	0%	2%	1%	3%	1%	4%	10%	10%	1%	2%	0%	3%
N.4	Draft contracts & proforma bidders pack	3%	8%	2%	7%	10%	10%	5%	25%	1%	4%	1%	3%	1%	7%	10%	15%	2%	4%	0%	3%
N.5	Contracting strategy	3%	9%	2%	7%	8%	8%	5%	30%	2%	8%	2%	5%	1%	7%	10%	30%	2%	4%	1%	5%
N.6	Procurement operation plan (POP)	2%	8%	2%	7%	10%	10%	5%	25%	1%	4%	2%	10%	1%	8%	10%	20%	2%	4%	1%	5%
O	**DELIVERABLES**																				
O.1	CADD/Model Requirements	1%	8%	1%	3%	8%	8%	5%	20%	0%	2%	1%	3%	1%	5%	5%	15%	1%	2%	0%	4%
O.2	Deliverables Defined	2%	8%	3%	8%	10%	10%	5%	30%	0%	1%	1%	3%	1%	10%	5%	20%	2%	4%	0%	6%
O.3	Distribution Matrix	1%	6%	1%	2%	8%	8%	5%	20%	0%	0%	1%	3%	1%	8%	5%	15%	1%	2%	0%	4%
O.4	Documentation/Deliverables	2%	7%	3%	8%	8%	8%	5%	25%	0%	1%	2%	10%	1%	5%	5%	15%	1%	2%	0%	4%
P	**PROJECT CONTROLS**																				
P.1	Project Quality Assurance and Control	2%	8%	1%	5%	10%	10%	5%	25%	0%	2%	5%	20%	2%	15%	5%	20%	2%	4%	1%	5%
P.2	Project Cost Control	2%	9%	1%	5%	10%	10%	5%	25%	1%	3%	5%	35%	2%	10%	5%	20%	5%	10%	0%	4%
P.3	Project Schedule Control	2%	9%	2%	6%	10%	10%	5%	25%	1%	5%	5%	35%	2%	15%	5%	20%	5%	10%	0%	4%
P.4	Risk Management	3%	8%	3%	8%	5%	15%	5%	25%	2%	5%	2%	15%	2%	10%	5%	20%	2%	4%	1%	4%
P.5	Safety, Health, Hygiene, and security Management	2%	6%	3%	8%	10%	10%	5%	25%	1%	5%	5%	35%	1%	5%	5%	20%	6%	12%	1%	5%
P.6	Environmental Management	3%	8%	2%	8%	5%	5%	5%	25%	1%	5%	2%	15%	1%	5%	5%	20%	3%	6%	1%	4%
P.7	Project Change Control	3%	10%	5%	10%	8%	8%	5%	25%	2%	6%	10%	35%	2%	15%	5%	20%	3%	6%	1%	5%
P.8	Project Audits	2%	6%	2%	7%	5%	5%	5%	25%	0%	2%	2%	5%	1%	6%	5%	20%	0%	1%	1%	4%

Annexure G (Continued) – List of Individual contributions, before normalization

P	**PROJECT CONTROLS**																				
P.9	Decision register	2%	9%	2%	10%	5%	5%	5%	25%	1%	4%	2%	5%	1%	16%	5%	20%	2%	4%	1%	4%
Q	**PROJECT IMPLEMENTATION PLAN**																				
Q.1	Engineering / Construction Plan & Approach	3%	9%	2%	10%	10%	10%	5%	25%	2%	10%	2%	5%	4%	20%	5%	20%	3%	6%	1%	6%
Q.2	Project Organization	2%	6%	5%	10%	8%	8%	5%	25%	1%	5%	2%	5%	2%	20%	5%	20%	4%	8%	1%	8%
Q.3	Responsibility matrix RACI	2%	7%	2%	8%	8%	8%	5%	25%	0%	2%	2%	5%	2%	15%	5%	20%	2%	4%	1%	6%
Q.4	Document Management Plan	1%	6%	1%	5%	5%	5%	5%	25%	0%	1%	2%	5%	2%	8%	5%	20%	1%	2%	1%	4%
Q.5	Communication management plan	3%	7%	2%	7%	5%	5%	5%	25%	0%	1%	2%	5%	2%	6%	5%	20%	2%	4%	1%	4%
Q.6	Project Delivery Method	1%	8%	2%	8%	5%	5%	5%	30%	2%	8%	2%	5%	2%	8%	5%	20%	3%	6%	1%	6%
Q.7	Design / Construction Plan and Approach	2%	8%	2%	8%	10%	10%	5%	25%	2%	6%	2%	5%	2%	30%	5%	20%	3%	6%	1%	6%
Q.8	Safety Procedures	1%	7%	2%	8%	10%	10%	5%	25%	1%	4%	2%	5%	2%	8%	5%	20%	3%	6%	1%	6%
Q.9	Intercompany Agreements	2%	8%	1%	8%	5%	5%	5%	20%	0%	2%	2%	5%	1%	5%	5%	20%	2%	4%	1%	4%
Q.10	Deliverables for Design and Construction	2%	8%	2%	8%	8%	8%	5%	25%	2%	7%	10%	25%	2%	20%	5%	20%	3%	6%	1%	3%
Q.11	Labour and Skilled resources plan	2%	9%	2%	8%	5%	5%	5%	25%	2%	12%	5%	10%	2%	10%	5%	20%	3%	6%	1%	3%
R	**HANDOVER & OPERATIONAL READINESS**																				
R.1	Commissioning plan	2%	8%	5%	10%	10%	10%	5%	25%	2%	4%	10%	25%	2%	15%	5%	20%	4%	8%	1%	4%
R.2	Start–up Requirements & plans	2%	7%	2%	8%	8%	8%	5%	25%	1%	3%	5%	15%	2%	20%	5%	20%	3%	6%	1%	4%
R.3	Training Requirements	2%	7%	1%	5%	8%	8%	5%	25%	1%	2%	5%	15%	2%	15%	10%	30%	1%	2%	1%	4%
R.4	Substantial Completion Requirements	2%	7%	1%	5%	8%	8%	5%	25%	1%	2%	5%	15%	2%	15%	5%	20%	1%	2%	1%	4%
R.5	Deliverables for Project Commissioning / Closeout	2%	8%	2%	6%	8%	8%	5%	25%	1%	2%	2%	10%	3%	25%	5%	20%	2%	4%	1%	4%
R.6	Long term supply chain contracts	3%	8%	2%	6%	5%	5%	5%	25%	1%	2%	2%	5%	1%	10%	10%	35%	3%	6%	1%	4%

Annexure G (Continued) – List of Individual contributions, before normalization

R	**HANDOVER & OPERATIONAL READINESS**																				
R.7	Resourcing & staffing for operation	4%	8%	2%	6%	5%	5%	5%	25%	2%	4%	5%	15%	2%	10%	10%	35%	2%	4%	1%	5%
R.8	Maintenance schedules	2%	7%	1%	5%	5%	5%	5%	25%	1%	2%	2%	5%	1%	7%	5%	35%	1%	2%	1%	5%
R.9	Critical spares	4%	8%	1%	5%	8%	8%	5%	25%	1%	3%	2%	5%	1%	7%	5%	25%	1%	2%	1%	4%
R.10	Start–up consumables	3%	7%	1%	5%	5%	5%	5%	25%	0%	1%	2%	5%	1%	8%	5%	20%	2%	4%	1%	4%
R.11	Operational systems and procedures to support each department	2%	8%	1%	5%	8%	8%	5%	25%	1%	3%	1%	3%	1%	18%	5%	30%	2%	4%	1%	4%
R.12	Environmental Management Plan for Operations (EMP)	2%	7%	1%	5%	8%	8%	5%	25%	1%	3%	5%	15%	1%	15%	5%	30%	3%	6%	1%	4%
		1%	10%	0%	20%	5%	20%	5%	50%	0%	50%	1%	35%	1%	35%	2%	50%	0%	12%	0%	50%
	Normalising Factor		10,00		5,00		5,00		2,00		2,00		2,86		2,86		2,00		8,33		2,00

SECTION IV – IMPLEMENTATION APPROACH		**P11**		**P12**		**P13**		**P14**		**P15**		**P16**		**P17**		**P18**		**P19**	
N	**PROCUREMENT STRATEGY**																		
N.1	Identify Long Lead/Critical Equipment and Materials	2%	10%	2%	15%	1%	2%	1%	5%	5%	20%	2%	20%	5%	50%	2%	5%	2%	6%
N.2	Procurement Procedures and Plans	1%	8%	0%	10%	1%	4%	1%	5%	5%	10%	2%	25%	1%	10%	2%	4%	1%	3%
N.3	Procurement Responsibility Matrix	1%	7%	0%	10%	1%	3%	1%	5%	2%	10%	3%	20%	1%	10%	2%	3%	0%	1%
N.4	Draft contracts & proforma bidders pack	1%	7%	2%	15%	3%	7%	1%	5%	1%	5%	2%	15%	1%	10%	2%	4%	2%	5%
N.5	Contracting strategy	1%	8%	0%	15%	3%	7%	1%	5%	3%	10%	2%	20%	5%	25%	2%	5%	4%	10%
N.6	Procurement operation plan (POP)	1%	8%	0%	10%	2%	5%	2%	5%	2%	15%	2%	20%	1%	10%	2%	5%	2%	8%

Annexure G (Continued) – List of Individual contributions, before normalization

O	**DELIVERABLES**																		
O.1	CADD/Model Requirements	1%	6%	5%	10%	2%	5%	1%	3%	20%	30%	2%	15%	0%	15%	2%	4%	2%	5%
O.2	Deliverables Defined	1%	7%	0%	25%	3%	7%	1%	3%	10%	20%	3%	25%	1%	25%	2%	4%	3%	6%
O.3	Distribution Matrix	1%	6%	0%	5%	2%	4%	1%	3%	10%	20%	2%	15%	0%	5%	1%	3%	2%	4%
O.4	Documentation/Deliverables	1%	5%	0%	2%	3%	6%	1%	3%	5%	15%	2%	20%	1%	15%	1%	3%	4%	7%
P	**PROJECT CONTROLS**																		
P.1	Project Quality Assurance and Control	1%	5%	5%	15%	3%	7%	0%	3%	5%	10%	5%	20%	7%	35%	2%	4%	1%	3%
P.2	Project Cost Control	1%	7%	0%	30%	1%	3%	0%	3%	10%	25%	3%	20%	7%	35%	2%	4%	3%	6%
P.3	Project Schedule Control	1%	7%	0%	25%	1%	4%	0%	3%	10%	30%	3%	20%	7%	35%	2%	6%	4%	6%
P.4	Risk Management	1%	8%	5%	15%	3%	6%	0%	3%	5%	15%	2%	20%	7%	35%	2%	4%	4%	7%
P.5	Safety, Health, Hygiene and Security Management	1%	5%	0%	10%	2%	5%	0%	3%	5%	10%	2%	20%	5%	25%	2%	6%	2%	8%
P.6	Environmental Management	1%	5%	0%	10%	1%	2%	0%	3%	5%	20%	2%	20%	5%	35%	2%	4%	4%	9%
P.7	Project Change Control	1%	5%	0%	30%	1%	3%	1%	3%	10%	40%	2%	20%	7%	35%	2%	5%	5%	8%
P.8	Project Audits	1%	4%	5%	10%	1%	2%	0%	3%	5%	10%	2%	15%	2%	35%	2%	4%	2%	4%
P.9	Decision register	1%	4%	0%	15%	1%	2%	0%	3%	5%	10%	2%	10%	7%	35%	2%	6%	4%	7%
Q	**PROJECT IMPLEMENTATION PLAN**																		
Q.1	Engineering / Construction Plan & Approach	1%	7%	5%	15%	2%	5%	0%	3%	5%	25%	4%	25%	5%	25%	2%	6%	3%	8%
Q.2	Project Organization	1%	9%	0%	20%	4%	9%	0%	3%	5%	10%	3%	20%	5%	25%	2%	5%	2%	4%
Q.3	Responsibility matrix RACI	1%	9%	0%	10%	3%	5%	0%	3%	5%	10%	2%	20%	5%	20%	2%	8%	2%	3%
Q.4	Document Management Plan	1%	4%	0%	5%	2%	4%	0%	3%	1%	5%	2%	20%	1%	15%	2%	5%	1%	2%
Q.5	Communication management plan	1%	5%	0%	5%	2%	4%	0%	3%	5%	10%	2%	20%	10%	35%	2%	5%	1%	2%
Q.6	Project Delivery Method	1%	9%	0%	10%	3%	7%	0%	3%	5%	20%	2%	25%	5%	25%	2%	6%	3%	5%
Q.7	Design / Construction Plan	1%	9%	5%	15%	3%	7%	0%	3%	5%	10%	2%	20%	5%	25%	2%	5%	2%	4%
Q.8	Safety Procedures	1%	5%	0%	10%	2%	5%	0%	3%	5%	20%	3%	15%	1%	5%	2%	4%	4%	8%
Q.9	Intercompany Agreements	1%	4%	0%	5%	1%	2%	0%	3%	2%	10%	2%	10%	2%	25%	2%	4%	2%	5%

Annexure G (Continued) – List of Individual contributions, before normalization

Q	**PROJECT IMPLEMENTATION PLAN**																		
Q.10	Deliverables for Design and Construction	1%	7%	5%	25%	2%	4%	0%	3%	5%	20%	3%	25%	1%	25%	2%	4%	3%	9%
Q.11	Labour and Skilled resources plan	1%	10%	5%	15%	2%	4%	0%	3%	5%	10%	3%	20%	10%	50%	2%	4%	3%	7%
R	**HANDOVER & OPERATIONAL READINESS**																		
R.1	Commissioning plan	1%	9%	5%	15%	2%	5%	0%	3%	5%	15%	3%	20%	5%	25%	2%	5%	1%	4%
R.2	Start–up Requirements & plans	2%	10%	5%	25%	3%	4%	0%	3%	2%	10%	3%	20%	5%	25%	2%	4%	1%	3%
R.3	Training Requirements	2%	9%	0%	10%	1%	2%	0%	3%	5%	10%	3%	20%	5%	25%	0%	4%	2%	5%
R.4	Substantial Completion Requirements	2%	9%	5%	20%	2%	4%	0%	3%	5%	15%	3%	20%	5%	25%	0%	5%	3%	5%
R.5	Deliverables for Project Commissioning / Closeout	1%	6%	0%	15%	2%	4%	0%	3%	2%	10%	3%	20%	5%	25%	0%	4%	3%	7%
R.6	Long term supply chain contracts	2%	9%	0%	10%	1%	2%	0%	3%	5%	10%	3%	20%	5%	25%	0%	5%	2%	5%
R.7	Resourcing & staffing for operation	2%	10%	5%	10%	1%	2%	0%	3%	1%	5%	3%	20%	5%	25%	0%	4%	3%	6%
R.8	Maintenance schedules	1%	7%	0%	10%	1%	2%	0%	3%	5%	15%	2%	10%	5%	25%	0%	4%	3%	4%
R.9	Critical spares	1%	6%	5%	15%	1%	2%	2%	3%	2%	10%	2%	15%	5%	25%	1%	5%	2%	4%
R.10	Start–up consumables	1%	8%	5%	10%	1%	2%	1%	3%	5%	15%	2%	10%	5%	25%	1%	3%	3%	5%
R.11	Operational systems and procedures to support each department	1%	8%	0%	5%	1%	2%	0%	3%	10%	20%	2%	10%	5%	25%	1%	4%	1%	3%
R.12	Environmental Management Plan for Operations (EMP)	1%	7%	5%	15%	1%	2%	0%	3%	10%	30%	2%	25%	5%	25%	2%	4%	2%	5%
		1%	30%	0%	35%	1%	15%	0%	15%	1%	60%	1%	50%	0%	50%	0%	15%	0%	12%
			3,33		2,86		6,67		6,67		1,67		2,00		2,00		6,67		8,33

8.8 Annexure H – List of Individual contributions, after normalisation

SECTION I – BASIS OF PROJECT DECISION		Normalised																			
	CATEGORY Element	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
A	PROJECT STRATEGY																				
A.1	Project Justification	2%	80%	2%	50%	5%	100%	7%	50%	0%	2%	5%	71%	1%	71%	5%	50%	2%	67%	3%	24%
A.2	Project Charter and Mandate	4%	90%	2%	25%	5%	75%	7%	50%	0%	2%	2%	29%	2%	57%	5%	50%	3%	75%	2%	24%
A.3`	Governance and control (internal approval process defined)	5%	100%	2%	35%	5%	50%	5%	40%	0%	2%	2%	71%	1%	14%	5%	50%	5%	83%	2%	20%
A.5	Project Strategy	2%	60%	2%	25%	8%	50%	5%	60%	0%	2%	1%	14%	1%	29%	5%	50%	6%	100%	3%	16%
A.6	Strategic fit of project in organisation	1%	60%	1%	50%	8%	25%	5%	50%	1%	2%	1%	14%	1%	43%	5%	50%	4%	67%	2%	16%
A.7	Due diligence	2%	70%	2%	50%	6%	25%	5%	50%	0%	2%	10%	71%	1%	57%	5%	50%	4%	67%	3%	16%
A.8	Partnership, joint ventures, and shareholder buy in	5%	100%	2%	25%	6%	100%	5%	60%	1%	10%	1%	29%	1%	71%	5%	50%	5%	92%	3%	16%
B	COUNTRY RISK																				
B.1	Social Issues	1%	70%	2%	20%	5%	50%	5%	70%	1%	10%	5%	71%	2%	57%	10%	60%	2%	50%	4%	30%
B.2	Geo–political risks	2%	70%	2%	20%	5%	50%	5%	70%	1%	6%	2%	43%	3%	86%	10%	60%	2%	50%	4%	12%
B.3	Fiscal stability agreement	3%	80%	2%	25%	8%	50%	5%	70%	1%	6%	2%	14%	3%	57%	10%	100%	1%	17%	2%	10%
B.4	Social License to Operate	2%	80%	2%	20%	5%	50%	5%	70%	1%	20%	10%	100%	2%	43%	10%	100%	3%	50%	4%	30%
B.5	Violence and terrorism	3%	80%	2%	20%	5%	50%	5%	100%	1%	4%	2%	6%	2%	71%	10%	100%	1%	17%	2%	12%
B.6	Ability to appoint expatriates	5%	100%	1%	25%	8%	50%	5%	70%	1%	4%	1%	3%	5%	86%	10%	60%	1%	17%	2%	14%
B.7	Procurement of local and foreign materials, services, and equipment	5%	100%	2%	50%	8%	50%	5%	80%	0%	6%	1%	29%	5%	86%	10%	50%	3%	50%	2%	20%
B.8	Country infrastructure (power, roads, rail, water ports)	4%	90%	2%	50%	5%	50%	5%	70%	0%	10%	1%	43%	5%	57%	10%	100%	4%	67%	2%	30%
B.9	Custom duties & logistic routes	4%	100%	2%	25%	6%	50%	5%	70%	1%	6%	1%	14%	5%	71%	10%	100%	0%	8%	2%	20%

Annexure H (Continued)– List of Individual contributions, after normalisation

C	**PROJECT FEASIBILITY**																						
C.1	Resources secured (including land and mineral rights)	1%	100%	2%	50%	10%	100%	5%	70%	0%	10%	2%	100%	5%	86%	10%	100%	2%	50%	1%	100%
C.2	Financing secured (Internal, external, equity, debt)	2%	90%	1%	25%	10%	100%	5%	70%	0%	10%	1%	29%	2%	43%	10%	100%	4%	67%	1%	100%
C.3	Business Plan	3%	70%	1%	50%	8%	75%	5%	70%	0%	4%	5%	71%	2%	86%	10%	100%	2%	33%	2%	40%
C.4	Economic Analysis	4%	100%	1%	50%	8%	50%	5%	70%	0%	4%	5%	71%	2%	57%	10%	60%	1%	17%	5%	30%
C.5	Affordability / Feasibility	3%	70%	1%	50%	10%	100%	5%	70%	0%	6%	5%	71%	2%	86%	10%	100%	3%	50%	5%	50%
C.6	Contingencies (Capex & Opex)	5%	100%	5%	100%	5%	50%	5%	50%	3%	70%	10%	100%	5%	86%	10%	50%	2%	33%	3%	40%
C.7	Basis of Estimate	3%	80%	2%	35%	5%	50%	5%	50%	2%	10%	10%	100%	5%	100%	10%	40%	2%	33%	3%	30%
C.8	Scenario planning	2%	70%	1%	10%	8%	50%	5%	50%	2%	10%	5%	43%	5%	57%	10%	70%	1%	17%	2%	20%
D	**RESOURCE AND RESERVE STATEMENT**																				
D.1	Metallurgical yield	4%	80%	1%	25%	10%	100%	5%	70%	3%	60%			5%	100%	5%	100%	3%	50%	5%	40%
D.2	Reserve risks (including modifying factors)	4%	100%	1%	25%	10%	100%	5%	50%	15%	100%			5%	86%	5%	100%	4%	67%	5%	60%
D.3	Grade engineering / control	4%	90%	1%	25%	5%	50%	5%	50%	5%	30%			5%	43%	5%	60%	2%	33%	3%	20%
D.4	Prospect drilling standard / guideline	3%	80%	1%	35%	10%	75%	5%	50%	3%	10%			5%	29%	5%	60%	1%	17%	2%	30%
D.5	Geological conditions (Geological model, structure, qualities)	3%	100%	1%	25%	10%	50%	5%	50%	5%	50%			5%	57%	5%	100%	4%	67%	5%	80%
D.6	Hydrogeology	2%	80%	1%	25%	10%	50%	5%	50%	5%	20%			2%	20%	5%	60%	1%	17%	5%	30%
E	**LIFE OF MINE PLANNING**																				
E.1	Mine design criteria	3%	100%	1%	35%	8%	50%	5%	50%	1%	10%	2%	43%	5%	57%	10%	60%	2%	33%	2%	50%

Annexure H (Continued) – List of Individual contributions, after normalisation

E	**LIFE OF MINE PLANNING**																				
E.2	Shaft/ramp design & men and material logistics	3%	100%	2%	25%	8%	25%	5%	50%	0%	2%	2%	43%	5%	43%	10%	60%	2%	33%	2%	50%
E.3	Mining methods (drilling, blasting, loading, hauling)	2%	80%	2%	25%	5%	50%	5%	50%	0%	10%	5%	57%	2%	29%	10%	60%	2%	33%	2%	50%
E.4	Equipment selection to fit geological conditions and mining method	2%	80%	2%	25%	8%	25%	5%	50%	1%	10%	5%	57%	5%	57%	10%	60%	2%	33%	2%	40%
E.5	Life–of–mine plan	4%	90%	2%	35%	10%	100%	5%	50%	0%	20%	10%	100%	2%	29%	10%	100%	3%	50%	1%	30%
E.6	Waste management plan	2%	70%	1%	25%	8%	25%	5%	50%	0%	2%	10%	100%	2%	29%	10%	60%	2%	33%	1%	30%
E.7	Ultimate pit limits designed	2%	70%	1%	25%	10%	50%	5%	50%	3%	20%	2%	43%	2%	14%	10%	60%	2%	33%	1%	30%
E.8	Economic block values determination	3%	90%	1%	15%	8%	50%	5%	50%	3%	50%	10%	100%	2%	86%	10%	100%	2%	33%	2%	30%
E.9	Beneficiation facilities LOM plan	4%	80%	2%	25%	8%	50%	5%	50%	3%	24%	5%	57%	2%	86%	10%	100%	2%	33%	2%	20%
E.10	Materials handling LOM plan	4%	80%	2%	25%	8%	50%	5%	50%	1%	6%	5%	57%	2%	86%	10%	100%	1%	17%	2%	20%
F	**OPERATING PHILOSOPHY**																				
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	3%	100%	2%	20%	8%	50%	5%	40%	0%	10%	1%	14%	2%	29%	5%	40%	3%	50%	2%	16%
F.2	Productivity / efficiency benchmarks	2%	90%	2%	25%	5%	25%	5%	40%	1%	6%	1%	3%	2%	14%	5%	30%	3%	50%	2%	12%
F.3	Operating costs	2%	70%	1%	35%	10%	50%	5%	60%	10%	70%	5%	43%	2%	57%	5%	100%	3%	50%	2%	20%
F.4	Production risks	2%	70%	1%	35%	5%	40%	5%	60%	5%	70%	1%	43%	5%	71%	10%	60%	3%	50%	2%	20%
F.5	Catalogue of operating plans	3%	80%	1%	25%	5%	25%	5%	40%	1%	10%	1%	3%	5%	57%	10%	40%	1%	17%	1%	10%
F.6	Haul roads	2%	80%	1%	20%	5%	50%	5%	50%	1%	8%	1%	14%	5%	29%	10%	70%	2%	33%	2%	14%
F.7	Transportation strategy	2%	90%	1%	20%	5%	40%	5%	50%	4%	30%	2%	29%	5%	29%	10%	40%	2%	33%	1%	16%

Annexure H (Continued)– List of Individual contributions, after normalisation

F	**OPERATING PHILOSOPHY**																				
F.8	Contractual considerations	2%	100%	1%	20%	5%	40%	5%	40%	1%	16%	2%	29%	5%	57%	5%	20%	2%	33%	2%	12%
G	**MARKET ANALYSIS AND STRATEGY**																				
G.1	Market Strategy & Sales Agreements	2%	80%	1%	25%	10%	50%	5%	50%	1%	20%	10%	100%	5%	86%	10%	100%	4%	67%	5%	30%
G.2	Price risks	4%	100%	2%	35%	8%	38%	5%	60%	5%	70%	10%	100%	5%	71%	10%	100%	5%	83%	5%	20%
G.3	Demand risks & replacement products / technologies	3%	90%	3%	35%	8%	38%	5%	60%	5%	50%	10%	100%	5%	86%	10%	100%	3%	50%	2%	20%
G.4	Value–Analysis Process	3%	70%	1%	25%	8%	38%	5%	50%	3%	30%	5%	57%	3%	14%	10%	70%	2%	33%	2%	30%
G.5	Hedging	2%	70%	1%	15%	5%	25%	5%	50%	3%	30%	2%	29%	3%	20%	10%	60%	1%	17%	2%	10%
G.6	Competitor analysis	3%	70%	1%	15%	5%	25%	5%	40%	1%	16%	1%	14%	2%	14%	10%	60%	3%	50%	2%	12%

SECTION I – BASIS OF PROJECT DECISION		Normalised																	
	CATEGORY Element	P11		P12		P13		P14		P15		P16		P17		P18		P19	
A	**PROJECT STRATEGY**																		
A.1	Project Justification	5%	33%	5%	43%	2%	33%	0%	20%	1%	17%	2%	40%	0%	100%	2%	100%	2%	42%
A.2	Project Charter and Mandate	3%	33%	5%	29%	1%	13%	0%	20%	2%	33%	2%	20%	0%	40%	5%	67%	5%	83%
A.3	Governance and control (internal approval process defined)	3%	50%	5%	71%	1%	13%	0%	27%	2%	33%	5%	30%	0%	40%	5%	100%	5%	83%
A.5	Project Strategy	5%	33%	5%	29%	3%	47%	0%	13%	1%	50%	5%	30%	0%	60%	2%	53%	1%	42%
A.6	Strategic fit of project in organisation	1%	50%	0%	14%	1%	20%	0%	13%	1%	25%	2%	60%	2%	60%	2%	33%	1%	58%
A.7	Due diligence	2%	67%	5%	57%	2%	27%	0%	13%	1%	17%	2%	40%	0%	100%	2%	33%	3%	67%
A.8	Partnership, joint ventures, and shareholder buy in	1%	17%	5%	29%	2%	27%	0%	13%	5%	50%	3%	20%	2%	40%	2%	33%	7%	100%

Annexure H (Continued)– List of Individual contributions, after normalisation

B	**COUNTRY RISK**																				
B.1	Social Issues	15%	67%	10%	86%	1%	33%	5%	33%	5%	67%	1%	20%	5%	10%	5%	100%	5%	100%
B.2	Geo–political risks	4%	37%	5%	86%	1%	13%	5%	33%	3%	50%	1%	20%	2%	10%	5%	53%	4%	75%
B.3	Fiscal stability agreement	2%	27%	0%	23%	1%	13%	5%	33%	1%	33%	2%	16%	2%	10%	2%	53%	6%	67%
B.4	Social License to Operate	5%	33%	0%	29%	1%	13%	5%	33%	5%	33%	3%	30%	2%	10%	2%	33%	2%	42%
B.5	Violence and terrorism	2%	27%	10%	86%	1%	7%	5%	33%	5%	83%	1%	10%	1%	10%	2%	33%	3%	42%
B.6	Ability to appoint expatriates	2%	20%	15%	100%	1%	20%	2%	13%	10%	50%	1%	10%	5%	10%	2%	40%	5%	92%
B.7	Procurement of local and foreign materials, services, and equipment	10%	67%	10%	71%	1%	13%	2%	13%	1%	17%	5%	30%	2%	10%	2%	33%	4%	58%
B.8	Country infrastructure (power, roads, rail, water ports)	3%	33%	10%	57%	1%	13%	5%	13%	2%	17%	3%	20%	2%	10%	2%	53%	5%	92%
B.9	Custom duties & logistic routes	2%	67%	10%	71%	1%	20%	2%	20%	5%	33%	3%	20%	1%	10%	2%	47%	3%	58%
C	**PROJECT FEASIBILITY**																				
C.1	Resources secured (including land and mineral rights)	1%	33%	0%	57%	1%	27%	2%	33%	1%	17%	5%	40%	0%	100%	1%	33%	4%	92%
C.2	Financing secured (Internal, external, equity, debt)	3%	37%	0%	14%	1%	33%	2%	33%	3%	42%	5%	30%	7%	100%	1%	27%	3%	58%
C.3	Business Plan	2%	30%	0%	29%	2%	27%	2%	27%	2%	33%	2%	30%	1%	10%	1%	33%	1%	42%
C.4	Economic Analysis	2%	33%	5%	43%	2%	20%	2%	33%	5%	50%	1%	30%	2%	60%	1%	33%	2%	58%
C.5	Affordability / Feasibility	2%	33%	0%	3%	1%	20%	2%	33%	1%	25%	1%	30%	5%	80%	1%	33%	3%	50%
C.6	Contingencies (Capex & Opex)	1%	33%	10%	57%	5%	100%	8%	100%	5%	33%	10%	60%	7%	60%	5%	100%	5%	83%
C.7	Basis of Estimate	1%	37%	5%	29%	1%	13%	2%	33%	1%	42%	5%	50%	7%	100%	2%	33%	4%	75%
C.8	Scenario planning	2%	40%	0%	43%	2%	40%	0%	13%	5%	17%	5%	40%	0%	50%	2%	27%	3%	42%
D	**RESOURCE AND RESERVE STATEMENT**																				
D.1	Metallurgical yield	1%	50%	0%	14%	1%	13%	2%	33%	1%	8%	10%	100%	2%	100%	5%	100%	3%	75%

Annexure H (Continued)– List of Individual contributions, after normalisation

D	**RESOURCE AND RESERVE STATEMENT**																		
D.2	Reserve risks (including modifying factors)	3%	53%	0%	14%	1%	13%	5%	67%	2%	17%	10%	100%	1%	100%	2%	100%	2%	42%
D.3	Grade engineering / control	4%	47%	0%	14%	1%	13%	5%	67%	1%	8%	10%	100%	2%	100%	2%	67%	3%	58%
D.4	Prospect drilling standard / guideline	2%	43%	0%	43%	1%	13%	2%	13%	2%	25%	5%	80%	1%	60%	2%	67%	2%	83%
D.5	Geological conditions (Geological model, structure, qualities)	4%	53%	0%	43%	1%	13%	5%	67%	5%	33%	10%	80%	5%	100%	2%	33%	4%	92%
D.6	Hydrogeology	5%	50%	5%	43%	1%	13%	2%	33%	5%	33%	5%	50%	1%	50%	2%	53%	5%	67%
E	**LIFE OF MINE PLANNING**																		
E.1	Mine design criteria	2%	47%	5%	29%	1%	13%	2%	27%	2%	17%	5%	50%	1%	100%	5%	67%	3%	75%
E.2	Shaft/ramp design & men and material logistics	2%	53%	5%	71%	1%	13%	2%	27%	2%	25%	5%	30%	1%	100%	2%	33%	4%	83%
E.3	Mining methods (drilling, blasting, loading, hauling)	2%	47%	0%	14%	1%	13%	2%	27%	1%	33%	5%	60%	1%	100%	2%	33%	1%	42%
E.4	Equipment selection to fit geological conditions and mining method	1%	30%	0%	14%	1%	13%	2%	27%	1%	8%	5%	60%	1%	100%	2%	33%	2%	58%
E.5	Life–of–mine plan	1%	17%	0%	14%	1%	13%	1%	13%	1%	25%	5%	50%	1%	50%	2%	27%	3%	58%
E.6	Waste management plan	3%	40%	5%	57%	1%	13%	1%	13%	3%	17%	5%	50%	1%	10%	2%	27%	2%	33%
E.7	Ultimate pit limits designed	1%	27%	0%	14%	1%	13%	1%	13%	1%	8%	5%	50%	5%	100%	2%	67%	3%	42%
E.8	Economic block values determination	3%	40%	0%	14%	1%	13%	1%	33%	2%	17%	5%	50%	3%	60%	2%	67%	4%	58%
E.9	Beneficiation facilities LOM plan	3%	33%	5%	43%	1%	13%	1%	33%	2%	25%	5%	50%	2%	50%	2%	53%	2%	33%
E.10	Materials handling LOM plan	3%	33%	5%	57%	1%	13%	1%	13%	5%	33%	5%	40%	1%	50%	2%	33%	5%	67%

Annexure H (Continued)– List of Individual contributions, after normalisation

F	**OPERATING PHILOSOPHY**																				
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	2%	27%	0%	14%	1%	13%	1%	13%	3%	17%	3%	30%	5%	80%	2%	33%	2%	75%
F.2	Productivity / efficiency benchmarks	3%	40%	2%	29%	2%	27%	0%	13%	2%	25%	4%	50%	1%	10%	5%	67%	2%	58%
F.3	Operating costs	3%	50%	5%	57%	1%	20%	2%	67%	1%	33%	4%	50%	5%	100%	5%	67%	4%	83%
F.4	Production risks	3%	50%	5%	57%	1%	13%	2%	33%	2%	25%	3%	40%	7%	100%	4%	67%	3%	50%
F.5	Catalogue of operating plans	1%	23%	5%	43%	1%	13%	0%	13%	2%	25%	2%	30%	1%	10%	4%	80%	4%	58%
F.6	Haul roads	2%	30%	0%	71%	1%	13%	1%	13%	1%	17%	2%	40%	0%	50%	1%	53%	3%	67%
F.7	Transportation strategy	3%	40%	5%	57%	1%	13%	0%	13%	1%	25%	2%	40%	2%	50%	1%	47%	1%	33%
F.8	Contractual considerations	4%	50%	5%	43%	2%	27%	0%	13%	5%	33%	2%	40%	2%	50%	2%	27%	2%	42%
G	**MARKET ANALYSIS AND STRATEGY**																				
G.1	Market Strategy & Sales Agreements	1%	27%	0%	14%	1%	13%	0%	33%	1%	8%	2%	50%	5%	70%	2%	67%	1%	25%
G.2	Price risks	3%	43%	0%	14%	1%	13%	5%	100%	2%	17%	5%	50%	10%	70%	2%	53%	3%	67%
G.3	Demand risks & replacement products / technologies	2%	50%	0%	14%	1%	13%	5%	67%	1%	8%	5%	30%	10%	100%	2%	67%	1%	25%
G.4	Value–Analysis Process	1%	23%	0%	14%	1%	13%	0%	20%	5%	25%	3%	30%	5%	70%	2%	40%	2%	33%
G.5	Hedging	1%	27%	0%	14%	1%	13%	0%	13%	1%	3%	2%	20%	5%	10%	4%	53%	3%	50%
G.6	Competitor analysis	1%	17%	0%	3%	1%	13%	0%	20%	5%	25%	2%	30%	2%	10%		0%	2%	58%

SECTION II – PROJECT DETAILS		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
H	**PROJECT CONSIDERATIONS**																				
H.1	Expected Project Life Cycle	3%	100%	1%	25%	5%	25%	5%	70%	1%	10%	10%	71%	5%	86%	10%	50%	2%	33%	2%	16%
H.2	Assumption register	2%	60%	1%	10%	5%	25%	5%	30%	3%	30%	2%	14%	5%	29%	10%	50%	1%	17%	1%	10%

Annexure H (Continued)– List of Individual contributions, after normalisation

F	**PROJECT CONSIDERATIONS**																				
H.3	Completion risks	3%	70%	3%	35%	5%	25%	5%	50%	5%	30%	2%	14%	5%	29%	10%	50%	2%	33%	1%	12%
H.4	Project Design Criteria	2%	80%	2%	25%	10%	25%	5%	70%	1%	30%	2%	14%	5%	86%	10%	70%	1%	17%	2%	20%
H.5	Scope of Work Overview	2%	80%	1%	35%	8%	100%	5%	70%	3%	50%	2%	14%	5%	86%	10%	100%	3%	50%	2%	20%
H.6	Project Schedule	4%	100%	2%	50%	8%	100%	5%	70%	5%	50%	10%	71%	2%	71%	10%	70%	4%	67%	2%	20%
H.7	Project Cost Estimate	4%	100%	5%	100%	10%	100%	5%	50%	3%	70%	10%	71%	5%	71%	10%	70%	4%	67%	2%	20%
H.8	Investment Studies & Alternatives Assessments	2%	70%	1%	75%	8%	50%	5%	50%	1%	10%	2%	29%	5%	43%	10%	50%	2%	33%	1%	40%
H.9	Key Team Member Coordination	2%	70%	0%	10%	5%	50%	5%	50%	1%	8%	2%	29%	5%	43%	10%	50%	4%	67%	0%	12%
H.10	Evaluation of Compliance Requirements	2%	80%	1%	25%	5%	40%	5%	70%	1%	6%	5%	43%	3%	71%	10%	100%	3%	50%	2%	40%
H.11	Lead / Discipline Scope of Work	1%	80%	0%	10%	10%	75%	5%	50%	2%	10%	2%	14%	3%	71%	10%	50%	3%	50%	1%	12%
H.12	Housing and transport of employees	3%	100%	0%	15%	8%	50%	5%	50%	1%	8%	2%	14%	3%	43%	10%	50%	2%	33%	2%	16%
H.13	Risk or impact on other projects / divisions	2%	70%	0%	5%	8%	25%	5%	50%	1%	10%	2%	14%	3%	29%	10%	50%	2%	33%	2%	12%
I	**PROJECT SCOPE**																				
I.1	Project Objectives Statement	1%	70%	0%	15%	10%	50%	5%	60%	0%	6%	2%	29%	3%	100%	10%	50%	3%	50%	0%	16%
I.2	Site Characteristics Available vs. Required	2%	70%	1%	15%	5%	25%	5%	50%	1%	10%	2%	29%	3%	86%	10%	50%	2%	33%	2%	10%
I.3	Project Scope Definition	2%	90%	1%	25%	10%	75%	5%	70%	3%	40%	10%	71%	3%	100%	10%	50%	3%	50%	2%	20%
I.4	WBS and WBS Dictionary	2%	80%	2%	25%	8%	50%	5%	50%	1%	20%	10%	71%	3%	100%	10%	50%	2%	33%	2%	20%
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																				
J.1	Unique mine closure plan	1%	70%	0%	25%	5%	50%	5%	50%	1%	6%	1%	14%	2%	29%	10%	40%	2%	33%	1%	10%
J.2	Land use plan post operations	1%	70%	1%	15%	5%	40%	5%	40%	1%	6%	1%	14%	2%	14%	10%	40%	1%	17%	1%	10%

Annexure H (Continued)– List of Individual contributions, after normalisation

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS																				
J.3	Social expectations register	2%	70%	1%	15%	5%	40%	5%	60%	2%	10%	1%	14%	2%	23%	10%	40%	2%	33%	1%	10%
J.4	Relocation Action Plan	2%	90%	2%	25%	8%	40%	5%	80%	2%	10%	10%	100%	2%	86%	10%	40%	3%	50%	2%	20%
J.5	Environmental expectations register	1%	80%	1%	25%	5%	25%	5%	50%	2%	16%	5%	43%	2%	57%	10%	40%	2%	33%	1%	20%
J.6	Political expectations register	2%	100%	1%	15%	5%	25%	5%	50%	3%	16%	1%	14%	2%	23%	10%	40%	4%	67%	1%	12%
J.7	Legal compliance register	2%	80%	2%	35%	10%	50%	5%	50%	1%	8%	10%	100%	2%	71%	10%	60%	3%	50%	1%	16%
J.8	HSE risk register	3%	80%	2%	25%	5%	25%	5%	40%	0%	6%	1%	14%	5%	51%	10%	60%	2%	33%	2%	20%
J.9	Community risk register	2%	70%	2%	25%	5%	25%	5%	50%	3%	16%	2%	29%	2%	43%	10%	60%	4%	67%	2%	12%
J.10	Business risk register	2%	70%	1%	25%	8%	25%	5%	50%	2%	16%	1%	14%	2%	57%	10%	60%	2%	33%	1%	14%
J.11	Developmental opportunity register	2%	70%	0%	15%	5%	25%	5%	50%	1%	6%	1%	14%	5%	29%	10%	40%	1%	17%	0%	6%
J.12	Sustainability operating plan	2%	70%	0%	15%	5%	50%	5%	50%	1%	6%	1%	14%	5%	29%	10%	50%	2%	33%	1%	12%
J.13	Stakeholder engagement plan	4%	90%	1%	15%	10%	50%	5%	50%	3%	10%	1%	14%	2%	29%	10%	50%	2%	33%	0%	14%
J.14	Mine closure financial provision plan	5%	90%	2%	25%	10%	50%	5%	50%	3%	30%	1%	14%	1%	29%	10%	60%	1%	17%	0%	8%
J.15	Closure plan review and updates scheduled during Life of Mine plan	2%	80%	1%	15%	5%	50%	5%	40%	1%	20%	1%	14%	2%	29%	5%	60%	1%	17%	0%	8%
J.16	Social investment plan	3%	70%	0%	10%	5%	50%	5%	60%	1%	6%	1%	14%	2%	23%	5%	40%	2%	33%	0%	12%
J.17	Economic diversification plan	2%	70%	0%	10%	5%	50%	5%	50%	1%	4%	1%	14%	1%	14%	5%	40%	2%	33%	0%	8%
J.18	Existing Environmental Conditions	1%	80%	1%	25%	5%	50%	5%	50%	2%	14%	1%	14%	1%	14%	5%	40%	1%	17%	1%	10%
J.19	Environmental Process determined	2%	70%	1%	25%	5%	50%	5%	50%	1%	16%	1%	14%	2%	23%	5%	40%	2%	33%	1%	12%
J.20	Environmental management plan	1%	70%	2%	25%	5%	50%	5%	50%	3%	24%	1%	14%	1%	14%	5%	40%	2%	33%	1%	12%

Annexure H (Continued)– List of Individual contributions, after normalisation

SECTION II – PROJECT DETAILS		P11		P12		P13		P14		P15		P16		P17		P18		P19	
H	**PROJECT CONSIDERATIONS**																		
H.1	Expected Project Life Cycle	1%	20%	5%	57%	3%	47%	1%	13%	5%	33%	5%	60%	5%	10%	0%	33%	3%	50%
H.2	Assumption register	1%	10%	1%	43%	2%	33%	1%	13%	2%	25%	2%	20%	3%	70%	5%	67%	4%	58%
H.3	Completion risks	1%	13%	5%	57%	3%	40%	1%	13%	5%	42%	2%	30%	10%	70%	5%	33%	2%	75%
H.4	Project Design Criteria	1%	17%	5%	71%	2%	27%	1%	13%	2%	50%	2%	50%	1%	70%	2%	67%	3%	92%
H.5	Scope of Work Overview	1%	33%	5%	86%	2%	33%	5%	67%	5%	50%	5%	60%	2%	70%	2%	100%	3%	83%
H.6	Project Schedule	1%	33%	5%	86%	4%	67%	2%	67%	5%	75%	5%	60%	5%	70%	2%	100%	2%	67%
H.7	Project Cost Estimate	1%	33%	5%	100%	5%	53%	5%	100%	5%	83%	5%	60%	5%	70%	10%	100%	0%	58%
H.8	Investment Studies & Alternatives Assessments	1%	27%	0%	29%	2%	27%	1%	27%	5%	25%	5%	50%	2%	70%	2%	53%	1%	33%
H.9	Key Team Member Coordination	1%	13%	5%	57%	1%	13%	0%	13%	2%	17%	5%	30%	7%	70%	2%	33%	1%	42%
H.10	Evaluation of Compliance Requirements	1%	10%	5%	86%	1%	13%	0%	13%	5%	33%	5%	50%	3%	70%	2%	33%	2%	33%
H.11	Lead / Discipline Scope of Work	1%	10%	5%	71%	2%	20%	2%	33%	2%	50%	5%	50%	2%	70%	5%	67%	3%	50%
H.12	Housing and transport of employees	1%	10%	5%	29%	1%	13%	2%	20%	1%	8%	2%	20%	1%	70%	2%	33%	2%	58%
H.13	Risk or impact on other projects / divisions	1%	17%	5%	29%	1%	13%	1%	13%	1%	8%	2%	20%	1%	70%	2%	53%	3%	83%
I	**PROJECT SCOPE**																		
I.1	Project Objectives Statement	1%	17%	0%	14%	1%	13%	0%	20%	2%	17%	2%	50%	1%	100%	2%	67%	1%	25%
I.2	Site Characteristics Available vs. Required	1%	20%	5%	20%	1%	13%	1%	13%	1%	42%	2%	40%	3%	70%	2%	67%	3%	42%
I.3	Project Scope Definition	1%	27%	5%	86%	2%	27%	2%	67%	5%	50%	5%	50%	2%	80%	5%	100%	2%	58%
I.4	WBS and WBS Dictionary	1%	33%	2%	86%	2%	27%	0%	33%	2%	67%	5%	50%	1%	70%	2%	100%	4%	50%
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																		
J.1	Unique mine closure plan	5%	50%	1%	29%	1%	13%	2%	33%	5%	50%	2%	16%	1%	40%	0%	33%	3%	58%

Annexure H (Continued)– List of Individual contributions, after normalisation

J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																		
J.2	Land use plan post operations	5%	50%	0%	14%	1%	13%	1%	13%	5%	83%	2%	16%	1%	40%	2%	33%	4%	50%
J.3	Social expectations register	5%	67%	5%	43%	1%	13%	0%	13%	1%	33%	3%	20%	1%	40%	2%	33%	3%	58%
J.4	Relocation Action Plan	15%	100%	10%	86%	1%	13%	2%	33%	2%	33%	3%	20%	1%	40%	2%	53%	2%	42%
J.5	Environmental expectations register	5%	43%	5%	43%	1%	13%	0%	20%	5%	25%	3%	30%	1%	40%	2%	33%	0%	25%
J.6	Political expectations register	5%	50%	5%	57%	1%	13%	0%	13%	2%	33%	1%	20%	1%	40%	2%	33%	1%	33%
J.7	Legal compliance register	4%	40%	5%	43%	1%	13%	0%	33%	1%	33%	1%	20%	1%	40%	2%	53%	4%	67%
J.8	HSE risk register	2%	27%	5%	29%	1%	13%	0%	33%	1%	33%	3%	30%	1%	40%	2%	53%	2%	33%
J.9	Community risk register	10%	67%	1%	43%	1%	13%	0%	33%	5%	42%	3%	20%	1%	40%	2%	53%	3%	67%
J.10	Business risk register	1%	23%	0%	29%	1%	13%	0%	33%	1%	25%	3%	30%	1%	40%	2%	53%	4%	42%
J.11	Developmental opportunity register	4%	47%	5%	57%	1%	13%	0%	33%	1%	17%	3%	30%	1%	40%	2%	33%	3%	50%
J.12	Sustainability operating plan	1%	27%	5%	43%	1%	13%	0%	33%	1%	33%	3%	20%	1%	40%	2%	33%	2%	33%
J.13	Stakeholder engagement plan	5%	53%	2%	29%	1%	13%	0%	33%	1%	33%	2%	20%	1%	40%	2%	67%	1%	33%
J.14	Mine closure financial provision plan	4%	50%	5%	86%	1%	13%	0%	33%	1%	8%	2%	30%	1%	40%	2%	33%	2%	75%
J.15	Closure plan review and updates scheduled during Life of Mine plan	1%	30%	0%	29%	1%	13%	0%	33%	2%	17%	2%	20%	1%	40%	2%	53%	2%	33%
J.16	Social investment plan	5%	47%	5%	86%	1%	13%	0%	33%	1%	33%	2%	20%	1%	40%	2%	33%	3%	50%
J.17	Economic diversification plan	3%	33%	5%	86%	1%	13%	0%	33%	1%	25%	2%	20%	1%	40%	2%	33%	3%	42%
J.18	Existing Environmental Conditions	1%	27%	2%	43%	1%	13%	0%	33%	1%	33%	2%	30%	1%	40%	2%	33%	4%	50%
J.19	Environmental Process determined	1%	33%	2%	29%	1%	13%	0%	33%	1%	25%	2%	30%	1%	40%	2%	33%	3%	50%
J.20	Environmental management plan	2%	40%	5%	71%	1%	13%	0%	33%	5%	100%	2%	30%	1%	40%	2%	53%	2%	33%

Annexure H (Continued)– List of Individual contributions, after normalisation

SECTION III – DESIGN FOR CONSTRUCTION		P1		P2		P3		P4		P5		P6		P7		P8		P9		P10	
K	**SITE INFORMATION**																				
K.1	Site Layout	2%	80%	2%	35%	5%	25%	5%	50%	1%	10%	2%	43%	1%	29%	10%	100%	1%	17%	1%	10%
K.2	Site Surveys	2%	80%	1%	25%	5%	25%	5%	50%	1%	10%	2%	43%	1%	14%	10%	100%	1%	17%	1%	10%
K.3	Governing Regulatory Requirements	4%	100%	0%	10%	10%	50%	5%	70%	0%	10%	1%	71%	1%	57%	10%	60%	2%	33%	1%	10%
K.4	Utility Sources with Supply Conditions	2%	90%	2%	25%	5%	25%	5%	60%	2%	10%	2%	57%	2%	71%	10%	50%	1%	17%	1%	10%
K.5	Fire Protection, emergency procedure & Safety Considerations	1%	60%	1%	25%	10%	50%	5%	50%	1%	10%	1%	14%	2%	29%	10%	40%	1%	17%	1%	8%
K.6	Special Water and Waste Treatment Requirements	2%	70%	2%	30%	5%	25%	5%	50%	1%	10%	1%	14%	2%	29%	10%	50%	2%	33%	1%	8%
K.7	Property Descriptions	1%	60%	1%	10%	5%	25%	5%	40%	2%	10%	1%	6%	2%	23%	10%	40%	1%	17%	0%	6%
K.8	Right–of–Way Mapping & Site Issues	2%	70%	1%	20%	5%	25%	5%	50%	1%	12%	1%	6%	2%	23%	10%	60%	1%	17%	1%	10%
K.9	Land Rights	3%	100%	3%	35%	10%	50%	5%	70%	3%	18%	1%	57%	2%	43%	10%	100%	3%	50%	0%	12%
L	**PROJECT DESIGN PARAMETERS**																				
L.1	Design Criteria	2%	80%	3%	35%	8%	50%	5%	70%	1%	6%	1%	9%	2%	29%	5%	60%	1%	17%	1%	16%
L.2	Civil/Site Design	2%	70%	5%	50%	8%	50%	5%	50%	2%	16%	1%	9%	2%	43%	5%	60%	2%	33%	1%	12%
L.3	Geotechnical investigation for structures	1%	70%	5%	50%	5%	35%	5%	50%	1%	10%	5%	71%	2%	43%	5%	60%	2%	33%	1%	20%
L.4	Architectural Design	1%	60%	2%	25%	5%	35%	5%	40%	0%	6%	1%	9%	2%	29%	5%	60%	1%	17%	1%	12%
L.5	Structural Design	2%	70%	3%	30%	8%	50%	5%	60%	2%	12%	1%	9%	2%	57%	5%	60%	2%	33%	1%	12%
L.6	Mechanical Design	2%	70%	3%	30%	8%	50%	5%	60%	2%	16%	1%	9%	2%	57%	5%	60%	2%	33%	1%	12%
L.7	Electrical Design	2%	70%	4%	40%	8%	50%	5%	60%	1%	10%	1%	9%	2%	43%	5%	60%	2%	33%	1%	12%
L.8	Constructability Analysis	3%	80%	5%	50%	5%	30%	5%	60%	2%	20%	1%	9%	3%	71%	5%	60%	2%	33%	1%	12%

Annexure H (Continued)– List of Individual contributions, after normalisation

L.9	Process Design	2%	100%	5%	75%		10%	50%	5%	50%	3%	30%	5%	71%	5%	86%	5%	60%	3%	50%	1%	20%
L.10	Specifications	2%	80%	2%	35%		8%	50%	5%	50%	1%	10%	1%	9%	1%	23%	5%	60%	2%	33%	1%	12%
L.11	Specialty Items List	1%	60%	1%	15%		5%	25%	5%	50%	0%	4%	1%	9%	3%	29%	5%	60%	1%	17%	1%	12%
L.12	Instrument Index	2%		70%	5%	50%	8%	50%	5%	50%	0%	6%	1%	9%	3%	23%	5%	60%	0%	8%	1%	10%
L.13	Control Philosophy & systems	2%		70%	3%	40%	8%	50%	5%	50%	1%	10%	1%	9%	1%	23%	5%	60%	3%	50%	1%	10%
L.14	Logic Diagrams	2%		70%	3%	40%	8%	50%	5%	50%	0%	4%	1%	9%	1%	23%	5%	60%	1%	17%	1%	10%
L.15	IM (information management)	2%		70%	2%	25%	8%	50%	5%	50%	1%	6%	1%	9%	3%	43%	5%	60%	1%	17%	1%	10%
L.16	Control of Access	1%		60%	1%	25%	5%	50%	5%	50%	0%	2%	1%	9%	2%	29%	5%	60%	1%	17%	1%	8%
L.17	Safety & Hazards	1%		60%	4%	50%	10%	50%	5%	50%	1%	4%	1%	9%	2%	29%	5%	60%	2%	33%	1%	12%
L.18	Operations/Maintenance	1%		60%	2%	25%	5%	50%	5%	50%	2%	12%	1%	9%	2%	23%	5%	60%	2%	33%	1%	12%
L.19	Ventilation Engineering	2%		80%	2%	25%	8%	40%	5%	50%	1%	6%	1%	9%	2%	29%	5%	60%	1%	17%	2%	40%
L.20	Rock Engineering	2%		80%	4%	50%	8%	40%	5%	50%	3%	16%	1%	9%	2%	29%	5%	60%	0%	8%	2%	40%
L.21	Water balances	2%		80%	2%	35%	8%	40%	5%	50%	2%	12%	5%	43%	2%	29%	5%	60%	2%	33%	1%	12%
L.22	Energy efficiency / carbon footprint	1%		60%	1%	25%	8%	40%	5%	50%	0%	4%	5%	43%	1%	14%	5%	60%	1%	17%	1%	10%
L.23	Tailings handling and storage	2%		80%	3%	50%	8%	40%	5%	50%	3%	18%	5%	43%	2%	29%	5%	60%	2%	33%	1%	30%
L.24	Stormwater handling / surface hydrology	2%		80%	3%	50%	8%	40%	5%	50%	2%	12%	5%	43%	1%	14%	5%	60%	1%	17%	1%	12%
L.25	Internal technical audits	1%		60%	1%	15%	5%	40%	5%	40%	0%	4%	1%	9%	1%	9%	5%	60%	3%	50%	0%	8%
L.26	External technical audits	1%		60%	1%	15%	5%	40%	5%	40%	0%	4%	1%	9%	1%	9%	5%	60%	1%	17%	0%	8%
M	**VALUE IMPROVING PRACTICES**																					
M.1	Process Simplification	2%		70%	2%	25%	5%	25%	5%	50%	0%	6%	1%	9%	2%	57%	5%	40%	1%	17%	0%	4%
M.2	Design & Material Alternatives Considered/Rejected	2%		70%	1%	20%	5%	25%	5%	40%	0%	6%	1%	9%	2%	29%	5%	30%	2%	33%	0%	4%
M.3	Technology trends	2%		70%	2%	25%	8%	38%	5%	40%	1%	6%	1%	9%	2%	23%	5%	30%	2%	33%	0%	4%
M.4	Design to capacity	2%		70%	2%	40%	10%	50%	5%	50%	1%	8%	1%	9%	2%	29%	5%	40%	2%	33%	0%	4%

Annexure H (Continued)– List of Individual contributions, after normalisation

M	VALUE IMPROVING PRACTICES																				
M.5	Classes of facility quality	2%	70%	1%	15%	5%	25%	5%	50%	0%	4%	1%	9%	1%	29%	5%	30%	1%	17%	0%	8%
M.6	Energy optimisation	2%	60%	1%	15%	5%	25%	5%	40%	0%	4%	1%	9%	2%	23%	5%	30%	2%	33%	0%	4%
M.7	Waste minimisation	1%	60%	2%	20%	8%	38%	5%	40%	1%	10%	1%	9%	2%	29%	5%	50%	2%	33%	0%	4%
M.8	3D / 4D design	2%	60%	2%	40%	10%	50%	5%	50%	1%	6%	1%	9%	2%	57%	5%	20%	1%	17%	0%	4%
M.9	Cleaner Production	2%	70%	1%	15%	5%	25%	5%	50%	0%	4%	1%	9%	1%	29%	5%	30%	2%	33%	0%	4%
M.10	Innovation and knowledge management planning	2%	60%	1%	20%	8%	38%	5%	40%	0%	2%	1%	9%	2%	29%	5%	20%	1%	17%	0%	4%
M.11	Six Sigma	1%	60%	1%	20%	5%	25%	5%	50%	0%	2%	1%	9%	2%	29%	2%	10%	0%	8%	0%	4%
M.12	Lean Manufacturing	1%	60%	2%	25%	5%	25%	5%	40%	0%	2%	1%	9%	3%	23%	2%	10%	0%	8%	0%	4%

SECTION III – DESIGN FOR CONSTRUCTION		P11		P12		P13		P14		P15		P16		P17		P18		P19	
K	SITE INFORMATION																		
K.1	Site Layout	1%	17%	2%	29%	2%	20%	2%	33%	5%	33%	5%	50%	2%	80%	3%	53%	3%	42%
K.2	Site Surveys	1%	20%	5%	43%	2%	33%	2%	33%	2%	25%	3%	40%	2%	80%	1%	33%	2%	33%
K.3	Governing Regulatory Requirements	1%	20%	1%	14%	1%	13%	2%	33%	1%	25%	3%	40%	2%	80%	1%	53%	3%	50%
K.4	Utility Sources with Supply Conditions	1%	23%	1%	14%	1%	13%	2%	33%	1%	33%	3%	40%	5%	100%	2%	33%	3%	58%
K.5	Fire Protection, emergency procedure & Safety Considerations	1%	17%	5%	29%	1%	13%	2%	33%	1%	17%	3%	40%	1%	10%	2%	33%	4%	75%
K.6	Special Water and Waste Treatment Requirements	1%	17%	0%	14%	1%	13%	2%	33%	3%	25%	3%	40%	0%	100%	2%	33%	4%	58%
K.7	Property Descriptions	1%	10%	0%	0%	1%	13%	2%	33%	1%	17%	1%	20%	0%	10%	2%	27%	1%	33%
K.8	Right–of–Way Mapping & Site Issues	1%	13%	0%	6%	1%	13%	2%	33%	2%	17%	2%	40%	1%	100%	2%	33%	2%	25%
K.9	Land Rights	1%	27%	0%	14%	1%	13%	2%	33%	1%	25%	2%	40%	1%	100%	2%	67%	2%	42%

Annexure H (Continued)– List of Individual contributions, after normalisation

L	PROJECT DESIGN PARAMETERS																		
L.1	Design Criteria	1%	33%	1%	43%	3%	33%	2%	33%	5%	25%	2%	50%	1%	70%	2%	53%	1%	33%
L.2	Civil/Site Design	1%	27%	1%	29%	3%	33%	2%	33%	5%	33%	2%	50%	1%	70%	2%	33%	2%	42%
L.3	Geotechnical investigation for structures	2%	43%	0%	14%	3%	33%	2%	33%	10%	50%	2%	50%	1%	70%	2%	33%	1%	50%
L.4	Architectural Design	1%	13%	0%	14%	3%	33%	1%	13%	10%	33%	2%	50%	1%	70%	2%	27%	3%	58%
L.5	Structural Design	1%	13%	5%	29%	3%	33%	2%	33%	10%	50%	2%	50%	1%	70%	2%	33%	2%	42%
L.6	Mechanical Design	1%	13%	5%	29%	3%	33%	2%	33%	5%	25%	2%	50%	1%	70%	2%	33%	3%	58%
L.7	Electrical Design	1%	13%	5%	29%	3%	33%	2%	33%	10%	67%	2%	50%	1%	70%	2%	33%	4%	75%
L.8	Constructability Analysis	3%	40%	5%	43%	3%	33%	2%	33%	10%	50%	3%	40%	1%	70%	2%	27%	3%	50%
L.9	Process Design	3%	47%	5%	57%	3%	33%	2%	33%	5%	33%	3%	40%	1%	70%	2%	67%	2%	58%
L.10	Specifications	1%	17%	0%	29%	3%	33%	2%	33%	10%	50%	2%	50%	1%	70%	2%	33%	3%	67%
L.11	Specialty Items List	1%	13%	2%	29%	3%	33%	2%	33%	10%	33%	2%	50%	1%	70%	2%	20%	3%	92%
L.12	Instrument Index	1%	27%	1%	14%	3%	33%	2%	33%	10%	33%	2%	30%	1%	70%	1%	20%	4%	67%
L.13	Control Philosophy & systems	1%	33%	0%	29%	3%	33%	2%	33%	10%	50%	2%	30%	1%	70%	1%	27%	5%	92%
L.14	Logic Diagrams	1%	27%	0%	14%	3%	33%	2%	33%	10%	50%	2%	30%	1%	70%	1%	20%	3%	67%
L.15	IM (information management)	1%	33%	0%	3%	3%	33%	2%	33%	5%	42%	2%	30%	1%	70%	1%	20%	3%	42%
L.16	Control of Access	1%	17%	0%	14%	3%	33%	2%	33%	2%	17%	2%	20%	1%	70%	0%	13%	3%	50%
L.17	Safety & Hazards	1%	33%	0%	14%	3%	33%	2%	33%	10%	50%	2%	30%	1%	70%	1%	20%	2%	50%
L.18	Operations/Maintenance	1%	23%	0%	14%	3%	33%	2%	33%	10%	67%	3%	40%	1%	70%	2%	53%	2%	75%
L.19	Ventilation Engineering	1%	27%	5%	29%	3%	33%	2%	33%	10%	33%	2%	30%	1%	70%	2%	53%	4%	75%
L.20	Rock Engineering	3%	40%	5%	29%	3%	33%	2%	33%	15%	67%	3%	40%	1%	70%	2%	40%	2%	42%
L.21	Water balances	1%	33%	0%	14%	3%	33%	2%	33%	10%	50%	3%	40%	1%	70%	2%	40%	2%	58%
L.22	Energy efficiency / carbon footprint	1%	17%	0%	3%	3%	33%	1%	13%	15%	67%	2%	20%	1%	70%	2%	33%	3%	50%
L.23	Tailings handling and storage	1%	20%	5%	43%	3%	33%	2%	53%	10%	50%	2%	20%	1%	70%	2%	33%	4%	83%

Annexure H (Continued)– List of Individual contributions, after normalisation

L	**PROJECT DESIGN PARAMETERS**																		
L.24	Stormwater handling / surface hydrology	1%	17%	0%	29%	3%	33%	2%	33%	10%	42%	2%	20%	1%	70%	2%	27%	3%	58%
L.25	Internal technical audits	1%	20%	0%	3%	3%	33%	2%	33%	5%	25%	2%	20%	1%	70%	2%	13%	1%	25%
L.26	External technical audits	1%	20%	0%	3%	3%	33%	1%	13%	5%	33%	2%	30%	1%	70%	2%	13%	3%	58%
M	**VALUE IMPROVING PRACTICES**																		
M.1	Process Simplification	1%	27%	0%	14%	2%	33%	1%	13%	10%	67%	3%	50%	0%	0%	2%	27%	3%	50%
M.2	Design & Material Alternatives Considered/Rejected	1%	27%	1%	14%	2%	27%	1%	13%	15%	50%	3%	50%	1%	50%	2%	27%	2%	42%
M.3	Technology trends	1%	23%	0%	14%	1%	20%	1%	13%	10%	50%	3%	40%	2%	50%	2%	20%	4%	67%
M.4	Design to capacity	1%	27%	1%	14%	1%	13%	1%	13%	5%	25%	2%	30%	2%	50%	2%	27%	2%	33%
M.5	Classes of facility quality	1%	23%	5%	29%	1%	13%	1%	13%	5%	33%	4%	40%	0%	0%	0%	13%	0%	25%
M.6	Energy optimisation	1%	30%	5%	43%	1%	20%	1%	13%	10%	33%	4%	40%	0%	0%	0%	13%	2%	42%
M.7	Waste minimisation	1%	30%	0%	14%	1%	13%	1%	13%	10%	33%	3%	40%	0%	0%	0%	27%	2%	58%
M.8	3D / 4D design	1%	30%	0%	29%	3%	40%	1%	13%	10%	50%	2%	30%	0%	0%	0%	20%	1%	42%
M.9	Cleaner Production	1%	27%	5%	29%	2%	27%	1%	13%	5%	17%	2%	30%	0%	0%	0%	13%	3%	67%
M.10	Innovation and knowledge management planning	1%	33%	0%	14%	2%	33%	1%	13%	10%	50%	4%	30%	0%	0%	2%	27%	2%	33%
M.11	Six Sigma	2%	37%	0%	29%	2%	33%	1%	13%	15%	33%	2%	30%	0%	0%	2%	27%	2%	42%
M.12	Lean Manufacturing	1%	27%	0%	14%	2%	33%	1%	13%	10%	50%	2%	30%	0%	0%	1%	20%	1%	42%

Annexure H (Continued)– List of Individual contributions, after normalisation

SECTION IV – IMPLEMENTATION APPROACH																					
N	**PROCUREMENT STRATEGY**	**P1**		**P2**		**P3**		**P4**		**P5**		**P6**		**P7**		**P8**		**P9**		**P10**	
N.1	Identify Long Lead/Critical Equipment and Materials	3%	80%	1%	35%	8%	38%	5%	70%	2%	16%	5%	43%	1%	14%	5%	20%	3%	50%	1%	10%
N.2	Procurement Procedures and Plans	2%	80%	1%	25%	10%	50%	5%	50%	1%	12%	2%	29%	2%	14%	10%	30%	2%	33%	1%	10%
N.3	Procurement Responsibility Matrix	2%	70%	1%	25%	10%	50%	5%	60%	0%	4%	1%	9%	1%	11%	10%	20%	1%	17%	0%	6%
N.4	Draft contracts & proforma bidders pack	3%	80%	2%	35%	10%	50%	5%	50%	1%	8%	1%	9%	1%	20%	10%	30%	2%	33%	0%	6%
N.5	Contracting strategy	3%	90%	2%	35%	8%	38%	5%	60%	2%	16%	2%	14%	1%	20%	10%	60%	2%	33%	1%	10%
N.6	Procurement operation plan (POP)	2%	80%	2%	35%	10%	50%	5%	50%	1%	8%	2%	29%	1%	23%	10%	40%	2%	33%	1%	10%
O	**DELIVERABLES**																				
O.1	CADD/Model Requirements	1%	80%	1%	15%	8%	38%	5%	40%	0%	4%	1%	9%	1%	14%	5%	30%	1%	17%	0%	8%
O.2	Deliverables Defined	2%	80%	3%	40%	10%	50%	5%	60%	0%	2%	1%	9%	1%	29%	5%	40%	2%	33%	0%	12%
O.3	Distribution Matrix	1%	60%	1%	10%	8%	38%	5%	40%	0%	0%	1%	9%	1%	23%	5%	30%	1%	17%	0%	8%
O.4	Documentation/Deliverables	2%	70%	3%	40%	8%	38%	5%	50%	0%	2%	2%	29%	1%	14%	5%	30%	1%	17%	0%	8%
P	**PROJECT CONTROLS**																				
P.1	Project Quality Assurance and Control	2%	80%	1%	25%	10%	50%	5%	50%	0%	4%	5%	57%	2%	43%	5%	40%	2%	33%	1%	10%
P.2	Project Cost Control	2%	90%	1%	25%	10%	50%	5%	50%	1%	6%	5%	100%	2%	29%	5%	40%	5%	83%	0%	8%
P.3	Project Schedule Control	2%	90%	2%	30%	10%	50%	5%	50%	1%	10%	5%	100%	2%	43%	5%	40%	5%	83%	0%	8%
P.4	Risk Management	3%	80%	3%	40%	5%	75%	5%	50%	2%	10%	2%	43%	2%	29%	5%	40%	2%	33%	1%	8%
P.5	Safety, Health, Hygiene, and security Management	2%	60%	3%	40%	10%	50%	5%	50%	1%	10%	5%	100%	1%	14%	5%	40%	6%	100%	1%	10%
P.6	Environmental Management	3%	80%	2%	40%	5%	25%	5%	50%	1%	10%	2%	43%	1%	14%	5%	40%	3%	50%	1%	8%
P.7	Project Change Control	3%	100%	5%	50%	8%	38%	5%	50%	2%	12%	10%	100%	2%	43%	5%	40%	3%	50%	1%	10%
P.8	Project Audits	2%	60%	2%	35%	5%	25%	5%	50%	0%	4%	2%	14%	1%	17%	5%	40%	0%	8%	1%	8%
P.9	Decision register	2%	90%	2%	50%	5%	25%	5%	50%	1%	8%	2%	14%	1%	46%	5%	40%	2%	33%	1%	8%

Annexure H (Continued)– List of Individual contributions, after normalisation

Q	**PROJECT IMPLEMENTATION PLAN**																				
Q.1	Engineering / Construction Plan & Approach	3%	90%	2%	50%	10%	50%	5%	50%	2%	20%	2%	14%	4%	57%	5%	40%	3%	50%	1%	12%
Q.2	Project Organization	2%	60%	5%	50%	8%	38%	5%	50%	1%	10%	2%	14%	2%	57%	5%	40%	4%	67%	1%	16%
Q.3	Responsibility matrix RACI	2%	70%	2%	40%	8%	38%	5%	50%	0%	4%	2%	14%	2%	43%	5%	40%	2%	33%	1%	12%
Q.4	Document Management Plan	1%	60%	1%	25%	5%	25%	5%	50%	0%	2%	2%	14%	2%	23%	5%	40%	1%	17%	1%	8%
Q.5	Communication management plan	3%	70%	2%	35%	5%	25%	5%	50%	0%	2%	2%	14%	2%	17%	5%	40%	2%	33%	1%	8%
Q.6	Project Delivery Method	1%	80%	2%	40%	5%	25%	5%	60%	2%	16%	2%	14%	2%	23%	5%	40%	3%	50%	1%	12%
Q.7	Design / Construction Plan and Approach	2%	80%	2%	40%	10%	50%	5%	50%	2%	12%	2%	14%	2%	86%	5%	40%	3%	50%	1%	12%
Q.8	Safety Procedures	1%	70%	2%	40%	10%	50%	5%	50%	1%	8%	2%	14%	2%	23%	5%	40%	3%	50%	1%	12%
Q.9	Intercompany Agreements	2%	80%	1%	40%	5%	25%	5%	40%	0%	4%	2%	14%	1%	14%	5%	40%	2%	33%	1%	8%
Q.10	Deliverables for Design and Construction	2%	80%	2%	40%	8%	38%	5%	50%	2%	14%	10%	71%	2%	57%	5%	40%	3%	50%	1%	6%
Q.11	Labour and Skilled resources plan	2%	90%	2%	40%	5%	25%	5%	50%	2%	24%	5%	29%	2%	29%	5%	40%	3%	50%	1%	6%
R	**HANDOVER & OPERATIONAL READINESS**																				
R.1	Commissioning plan	2%	80%	5%	50%	10%	50%	5%	50%	2%	8%	10%	71%	2%	43%	5%	40%	4%	67%	1%	8%
R.2	Start–up Requirements & plans	2%	70%	2%	40%	8%	38%	5%	50%	1%	6%	5%	43%	2%	57%	5%	40%	3%	50%	1%	8%
R.3	Training Requirements	2%	70%	1%	25%	8%	38%	5%	50%	1%	4%	5%	43%	2%	43%	10%	60%	1%	17%	1%	8%
R.4	Substantial Completion Requirements	2%	70%	1%	25%	8%	38%	5%	50%	1%	4%	5%	43%	2%	43%	5%	40%	1%	17%	1%	8%
R.5	Deliverables for Project Commissioning / Closeout	2%	80%	2%	30%	8%	38%	5%	50%	1%	4%	2%	29%	3%	71%	5%	40%	2%	33%	1%	8%
R.6	Long term supply chain contracts	3%	80%	2%	30%	5%	25%	5%	50%	1%	4%	2%	14%	1%	29%	10%	70%	3%	50%	1%	8%
R.7	Resourcing & staffing for operation	4%	80%	2%	30%	5%	25%	5%	50%	2%	8%	5%	43%	2%	29%	10%	70%	2%	33%	1%	10%
R.8	Maintenance schedules	2%	70%	1%	25%	5%	25%	5%	50%	1%	4%	2%	14%	1%	20%	5%	70%	1%	17%	1%	10%

Annexure H (Continued)– List of Individual contributions, after normalisation

R.9	Critical spares	4%	80%	1%	25%	8%	38%	5%	50%	1%	6%	2%	14%	1%	20%	5%	50%	1%	17%	1%	8%
R.10	Start–up consumables	3%	70%	1%	25%	5%	25%	5%	50%	0%	2%	2%	14%	1%	23%	5%	40%	2%	33%	1%	8%
R.11	Operational systems and procedures to support each department	2%	80%	1%	25%	8%	38%	5%	50%	1%	6%	1%	9%	1%	51%	5%	60%	2%	33%	1%	8%
R.12	Environmental Management Plan for Operations (EMP)	2%	70%	1%	25%	8%	38%	5%	50%	1%	6%	5%	43%	1%	43%	5%	60%	3%	50%	1%	8%

SECTION IV – IMPLEMENTATION APPROACH																			
N	**PROCUREMENT STRATEGY**	**P11**		**P12**		**P13**		**P14**		**P15**		**P16**		**P17**		**P18**		**P19**	
N.1	Identify Long Lead/Critical Equipment and Materials	2%	33%	2%	43%	1%	13%	1%	33%	5%	33%	2%	40%	5%	100%	2%	33%	2%	50%
N.2	Procurement Procedures and Plans	1%	27%	0%	29%	1%	27%	1%	33%	5%	17%	2%	50%	1%	20%	2%	27%	1%	25%
N.3	Procurement Responsibility Matrix	1%	23%	0%	29%	1%	20%	1%	33%	2%	17%	3%	40%	1%	20%	2%	20%	0%	8%
N.4	Draft contracts & proforma bidders pack	1%	23%	2%	43%	3%	47%	1%	33%	1%	8%	2%	30%	1%	20%	2%	27%	2%	42%
N.5	Contracting strategy	1%	27%	0%	43%	3%	47%	1%	33%	3%	17%	2%	40%	5%	50%	2%	33%	4%	83%
N.6	Procurement operation plan (POP)	1%	27%	0%	29%	2%	33%	2%	33%	2%	25%	2%	40%	1%	20%	2%	33%	2%	67%
O	**DELIVERABLES**																		
O.1	CADD/Model Requirements	1%	20%	5%	29%	2%	33%	1%	20%	20%	50%	2%	30%	0%	30%	2%	27%	2%	42%
O.2	Deliverables Defined	1%	23%	0%	71%	3%	47%	1%	20%	10%	33%	3%	50%	1%	50%	2%	27%	3%	50%
O.3	Distribution Matrix	1%	20%	0%	14%	2%	27%	1%	20%	10%	33%	2%	30%	0%	10%	1%	20%	2%	33%
O.4	Documentation/Deliverables	1%	17%	0%	6%	3%	40%	1%	20%	5%	25%	2%	40%	1%	30%	1%	20%	4%	58%
P	**PROJECT CONTROLS**																		
P.1	Project Quality Assurance and Control	1%	17%	5%	43%	3%	47%	0%	20%	5%	17%	5%	40%	7%	70%	2%	27%	1%	25%
P.2	Project Cost Control	1%	23%	0%	86%	1%	20%	0%	20%	10%	42%	3%	40%	7%	70%	2%	27%	3%	50%

Annexure H (Continued)– List of Individual contributions, after normalisation

P	**PROJECT CONTROLS**																		
P.3	Project Schedule Control	1%	23%	0%	71%	1%	27%	0%	20%	10%	50%	3%	40%	7%	70%	2%	40%	4%	50%
P.4	Risk Management	1%	27%	5%	43%	3%	40%	0%	20%	5%	25%	2%	40%	7%	70%	2%	27%	4%	58%
P.5	Safety, Health, Hygiene, and security Management	1%	17%	0%	29%	2%	33%	0%	20%	5%	17%	2%	40%	5%	50%	2%	40%	2%	67%
P.6	Environmental Management	1%	17%	0%	29%	1%	13%	0%	20%	5%	33%	2%	40%	5%	70%	2%	27%	4%	75%
P.7	Project Change Control	1%	17%	0%	86%	1%	20%	1%	20%	10%	67%	2%	40%	7%	70%	2%	33%	5%	67%
P.8	Project Audits	1%	13%	5%	29%	1%	13%	0%	20%	5%	17%	2%	30%	2%	70%	2%	27%	2%	33%
P.9	Decision register	1%	13%	0%	43%	1%	13%	0%	20%	5%	17%	2%	20%	7%	70%	2%	40%	4%	58%
Q	**PROJECT IMPLEMENTATION PLAN**																		
Q.1	Engineering / Construction Plan & Approach	1%	23%	5%	43%	2%	33%	0%	20%	5%	42%	4%	50%	5%	50%	2%	40%	3%	67%
Q.2	Project Organization	1%	30%	0%	57%	4%	60%	0%	20%	5%	17%	3%	40%	5%	50%	2%	33%	2%	33%
Q.3	Responsibility matrix RACI	1%	30%	0%	29%	3%	33%	0%	20%	5%	17%	2%	40%	5%	40%	2%	53%	2%	25%
Q.4	Document Management Plan	1%	13%	0%	14%	2%	27%	0%	20%	1%	8%	2%	40%	1%	30%	2%	33%	1%	17%
Q.5	Communication management plan	1%	17%	0%	14%	2%	27%	0%	20%	5%	17%	2%	40%	10%	70%	2%	33%	1%	17%
Q.6	Project Delivery Method	1%	30%	0%	29%	3%	47%	0%	20%	5%	33%	2%	50%	5%	50%	2%	40%	3%	42%
Q.7	Design / Construction Plan and Approach	1%	30%	5%	43%	3%	47%	0%	20%	5%	17%	2%	40%	5%	50%	2%	33%	2%	33%
Q.8	Safety Procedures	1%	17%	0%	29%	2%	33%	0%	20%	5%	33%	3%	30%	1%	10%	2%	27%	4%	67%
Q.9	Intercompany Agreements	1%	13%	0%	14%	1%	13%	0%	20%	2%	17%	2%	20%	2%	50%	2%	27%	2%	42%
Q.10	Deliverables for Design and Construction	1%	23%	5%	71%	2%	27%	0%	20%	5%	33%	3%	50%	1%	50%	2%	27%	3%	75%
Q.11	Labour and Skilled resources plan	1%	33%	5%	43%	2%	27%	0%	20%	5%	17%	3%	40%	10%	100%	2%	27%	3%	58%
R	**HANDOVER & OPERATIONAL READINESS**																		
R.1	Commissioning plan	1%	30%	5%	43%	2%	33%	0%	20%	5%	25%	3%	40%	5%	50%	2%	33%	1%	33%

Annexure H (Continued)– List of Individual contributions, after normalisation

R	HANDOVER & OPERATIONAL READINESS																				
R.2	Start–up Requirements & plans	2%	33%	5%	71%	3%	27%	0%	20%	2%	17%	3%	40%	5%	50%	2%	27%	1%	25%
R.3	Training Requirements	2%	30%	0%	29%	1%	13%	0%	20%	5%	17%	3%	40%	5%	50%	0%	27%	2%	42%
R.4	Substantial Completion Requirements	2%	30%	5%	57%	2%	27%	0%	20%	5%	25%	3%	40%	5%	50%	0%	33%	3%	42%
R.5	Deliverables for Project Commissioning / Closeout	1%	20%	0%	43%	2%	27%	0%	20%	2%	17%	3%	40%	5%	50%	0%	27%	3%	58%
R.6	Long term supply chain contracts	2%	30%	0%	29%	1%	13%	0%	20%	5%	17%	3%	40%	5%	50%	0%	33%	2%	42%
R.7	Resourcing & staffing for operation	2%	33%	5%	29%	1%	13%	0%	20%	1%	8%	3%	40%	5%	50%	0%	27%	3%	50%
R.8	Maintenance schedules	1%	23%	0%	29%	1%	13%	0%	20%	5%	25%	2%	20%	5%	50%	0%	27%	3%	33%
R.9	Critical spares	1%	20%	5%	43%	1%	13%	2%	20%	2%	17%	2%	30%	5%	50%	1%	33%	2%	33%
R.10	Start–up consumables	1%	27%	5%	29%	1%	13%	1%	20%	5%	25%	2%	20%	5%	50%	1%	20%	3%	42%
R.11	Operational systems and procedures to support each department	1%	27%	0%	14%	1%	13%	0%	20%	10%	33%	2%	20%	5%	50%	1%	27%	1%	25%
R.12	Environmental Management Plan for Operations (EMP)	1%	23%	5%	43%	1%	13%	0%	20%	10%	50%	2%	50%	5%	50%	2%	27%	2%	42%

8.9 Annexure I – Identification of outliers and extremes

SECTION I – BASIS OF PROJECT DECISION		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
A	PROJECT STRATEGY																			
A.1	Project Justification	80%	50%	100%	50%	2%	71%	71%	50%	67%	24%	33%	43%	33%	20%	17%	40%	100%	100%	42%
A.2	Project Charter and Mandate	90%	25%	75%	50%	2%	29%	57%	50%	75%	24%	33%	29%	13%	20%	33%	20%	40%	67%	83%
A.3	Governance and control (internal approval process defined)	100%	35%	50%	40%	2%	71%	14%	50%	83%	20%	50%	71%	13%	27%	33%	30%	40%	100%	83%
A.5	Project Strategy	60%	25%	50%	60%	2%	14%	29%	50%	100%	16%	33%	29%	47%	13%	50%	30%	60%	53%	42%
A.6	Strategic fit of project in organisation	60%	50%	25%	50%	2%	14%	43%	50%	67%	16%	50%	14%	20%	13%	25%	60%	60%	33%	58%
A.7	Due diligence	70%	50%	25%	50%	2%	71%	57%	50%	67%	16%	67%	57%	27%	13%	17%	40%	100%	33%	67%
A.8	Partnership, joint ventures, and shareholder buy in	100%	25%	100%	60%	10%	29%	71%	50%	92%	16%	17%	29%	27%	13%	50%	20%	40%	33%	100%
B	COUNTRY RISK																			
B.1	Social Issues	70%	20%	50%	70%	10%	71%	57%	60%	50%	30%	67%	86%	33%	33%	67%	20%	10%	100%	100%
B.2	Geo–political risks	70%	20%	50%	70%	6%	43%	86%	60%	50%	12%	37%	86%	13%	33%	50%	20%	10%	53%	75%
B.3	Fiscal stability agreement	80%	25%	50%	70%	6%	14%	57%	100%	17%	10%	27%	23%	13%	33%	33%	16%	10%	53%	67%
B.4	Social License to Operate	80%	20%	50%	70%	20%	100%	43%	100%	50%	30%	33%	29%	13%	33%	33%	30%	10%	33%	42%
B.5	Violence and terrorism	80%	20%	50%	100%	4%	6%	71%	100%	17%	12%	27%	86%	7%	33%	83%	10%	10%	33%	42%
B.6	Ability to appoint expatriates	100%	25%	50%	70%	4%	3%	86%	60%	17%	14%	20%	100%	20%	13%	50%	10%	10%	40%	92%
B.7	Procurement of local and foreign materials, services, and equipment	100%	50%	50%	80%	6%	29%	86%	50%	50%	20%	67%	71%	13%	13%	17%	30%	10%	33%	58%

Annexure I (Continued)– Identification of outliers and extremes

B	**COUNTRY RISK**																			
B.8	Country infrastructure (power, roads, rail, water ports)	90%	50%	50%	70%	10%	43%	57%	100%	67%	30%	33%	57%	13%	13%	17%	20%	10%	53%	92%
B.9	Custom duties & logistic routes	100%	25%	50%	70%	6%	14%	71%	100%	8%	20%	67%	71%	20%	20%	33%	20%	10%	47%	58%
C	**PROJECT FEASIBILITY**																			
C.1	Resources secured (including land and mineral rights)	100%	50%	100%	70%	10%	100%	86%	100%	50%	100%	33%	57%	27%	33%	17%	40%	100%	33%	92%
C.2	Financing secured (Internal, external, equity, debt)	90%	25%	100%	70%	10%	29%	43%	100%	67%	100%	37%	14%	33%	33%	42%	30%	100%	27%	58%
C.3	Business Plan	70%	50%	75%	70%	4%	71%	86%	100%	33%	40%	30%	29%	27%	27%	33%	30%	10%	33%	42%
C.4	Economic Analysis	100%	50%	50%	70%	4%	71%	57%	60%	17%	30%	33%	43%	20%	33%	50%	30%	60%	33%	58%
C.5	Affordability / Feasibility	70%	50%	100%	70%	6%	71%	86%	100%	50%	50%	33%	3%	20%	33%	25%	30%	80%	33%	50%
C.6	Contingencies (Capex & Opex)	100%	100%	50%	50%	70%	100%	86%	50%	33%	40%	33%	57%	100%	100%	33%	60%	60%	100%	83%
C.7	Basis of Estimate	80%	35%	50%	50%	10%	100%	100%	40%	33%	30%	37%	29%	13%	33%	42%	50%	100%	33%	75%
C.8	Scenario planning	70%	10%	50%	50%	10%	43%	57%	70%	17%	20%	40%	43%	40%	13%	17%	40%	50%	27%	42%
D	**RESOURCE AND RESERVE STATEMENT**																			
D.1	Metallurgical yield	80%	25%	100%	70%	60%		100%	100%	50%	40%	50%	14%	13%	33%	8%	100%	100%	100%	75%
D.2	Reserve risks (including modifying factors)	100%	25%	100%	50%	100%		86%	100%	67%	60%	53%	14%	13%	67%	17%	100%	100%	100%	42%
D.3	Grade engineering / control	90%	25%	50%	50%	30%		43%	60%	33%	20%	47%	14%	13%	67%	8%	100%	100%	67%	58%

Annexure I (Continued)– Identification of outliers and extremes

D	**RESOURCE AND RESERVE STATEMENT**																			
D.4	Prospect drilling standard / guideline	80%	35%	75%	50%	10%		29%	60%	17%	30%	43%	43%	13%	13%	25%	80%	60%	67%	83%
D.5	Geological conditions (Geological model, structure, qualities)	100%	25%	50%	50%	50%		57%	100%	67%	80%	53%	43%	13%	67%	33%	80%	100%	33%	92%
D.6	Hydrogeology	80%	25%	50%	50%	20%		20%	60%	17%	30%	50%	43%	13%	33%	33%	50%	50%	53%	67%
E	**LIFE OF MINE PLANNING**																			
E.1	Mine design criteria	100%	35%	50%	50%	10%	43%	57%	60%	33%	50%	47%	29%	13%	27%	17%	50%	100%	67%	75%
E.2	Shaft/ramp design & men and material logistics	100%	25%	25%	50%	2%	43%	43%	60%	33%	50%	53%	71%	13%	27%	25%	30%	100%	33%	83%
E.3	Mining methods (drilling, blasting, loading, hauling)	80%	25%	50%	50%	10%	57%	29%	60%	33%	50%	47%	14%	13%	27%	33%	60%	100%	33%	42%
E.4	Equipment selection to fit geological conditions and mining method	80%	25%	25%	50%	10%	57%	57%	60%	33%	40%	30%	14%	13%	27%	8%	60%	100%	33%	58%
E.5	Life–of–mine plan	90%	35%	100%	50%	20%	100%	29%	100%	50%	30%	17%	14%	13%	13%	25%	50%	50%	27%	58%
E.6	Waste management plan	70%	25%	25%	50%	2%	100%	29%	60%	33%	30%	40%	57%	13%	13%	17%	50%	10%	27%	33%
E.7	Ultimate pit limits designed	70%	25%	50%	50%	20%	43%	14%	60%	33%	30%	27%	14%	13%	13%	8%	50%	100%	67%	42%
E.8	Economic block values determination	90%	15%	50%	50%	50%	100%	86%	100%	33%	30%	40%	14%	13%	33%	17%	50%	60%	67%	58%
E.9	Beneficiation facilities LOM plan	80%	25%	50%	50%	24%	57%	86%	100%	33%	20%	33%	43%	13%	33%	25%	50%	50%	53%	33%
E.10	Materials handling LOM plan	80%	25%	50%	50%	6%	57%	86%	100%	17%	20%	33%	57%	13%	13%	33%	40%	50%	33%	67%

Annexure I (Continued)– Identification of outliers and extremes

F	**OPERATING PHILOSOPHY**																			
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	100%	20%	50%	40%	10%	14%	29%	40%	50%	16%	27%	14%	13%	13%	17%	30%	80%	33%	75%
F.2	Productivity / efficiency benchmarks	90%	25%	25%	40%	6%	3%	14%	30%	50%	12%	40%	29%	27%	13%	25%	50%	10%	67%	58%
F.3	Operating costs	70%	35%	50%	60%	70%	43%	57%	100%	50%	20%	50%	57%	20%	67%	33%	50%	100%	67%	83%
F.4	Production risks	70%	35%	40%	60%	70%	43%	71%	60%	50%	20%	50%	57%	13%	33%	25%	40%	100%	67%	50%
F.5	Catalogue of operating plans	80%	25%	25%	40%	10%	3%	57%	40%	17%	10%	23%	43%	13%	13%	25%	30%	10%	80%	58%
F.6	Haul roads	80%	20%	50%	50%	8%	14%	29%	70%	33%	14%	30%	71%	13%	13%	17%	40%	50%	53%	67%
F.7	Transportation strategy	90%	20%	40%	50%	30%	29%	29%	40%	33%	16%	40%	57%	13%	13%	25%	40%	50%	47%	33%
F.8	Contractual considerations	100%	20%	40%	40%	16%	29%	57%	20%	33%	12%	50%	43%	27%	13%	33%	40%	50%	27%	42%
G	**MARKET ANALYSIS AND STRATEGY**																			
G.1	Market Strategy & Sales Agreements	80%	25%	50%	50%	20%	100%	86%	100%	67%	30%	27%	14%	13%	33%	8%	50%	70%	67%	25%
G.2	Price risks	100%	35%	38%	60%	70%	100%	71%	100%	83%	20%	43%	14%	13%	100%	17%	50%	70%	53%	67%
G.3	Demand risks & replacement products / technologies	90%	35%	38%	60%	50%	100%	86%	100%	50%	20%	50%	14%	13%	67%	8%	30%	100%	67%	25%
G.4	Value–Analysis Process	70%	25%	38%	50%	30%	57%	14%	70%	33%	30%	23%	14%	13%	20%	25%	30%	70%	40%	33%
G.5	Hedging	70%	15%	25%	50%	30%	29%	20%	60%	17%	10%	27%	14%	13%	13%	3%	20%	10%	53%	50%
G.6	Competitor analysis	70%	15%	25%	40%	16%	14%	14%	60%	50%	12%	17%	3%	13%	20%	25%	30%	10%	0%	58%

Annexure I (Continued)– Identification of outliers and extremes

					Outliers				Extremes			
	SECTION I – BASIS OF PROJECT DECISION	Median	Q1	Q3	Lower	Higher	Lower count	Upper count	Lower	Higher	Lower count	Upper count
A	PROJECT STRATEGY											
A.1	Project Justification	50%	33%	71%	–24%	129%	0	0	–81%	186%	0	0
A.2	Project Charter and Mandate	33%	25%	62%	–32%	118%	0	0	–88%	174%	0	0
A.3	Governance and control (internal approval process defined)	40%	28%	71%	–36%	136%	0	0	–101%	201%	0	0
A.5	Project Strategy	42%	27%	52%	–11%	89%	0	1	–48%	126%	0	0
A.6	Strategic fit of project in organisation	43%	18%	54%	–36%	108%	0	0	–91%	163%	0	0
A.7	Due diligence	50%	26%	67%	–35%	128%	0	0	–97%	189%	0	0
A.8	Partnership, joint ventures, and shareholder buy in	33%	23%	66%	–42%	131%	0	0	–107%	195%	0	0
B	COUNTRY RISK											
B.1	Social Issues	57%	32%	70%	–26%	128%	0	0	–83%	185%	0	0
B.2	Geo–political risks	50%	20%	65%	–48%	133%	0	0	–115%	200%	0	0
B.3	Fiscal stability agreement	27%	15%	55%	–45%	115%	0	0	–105%	176%	0	0
B.4	Social License to Operate	33%	29%	50%	–2%	81%	0	2	–33%	112%	0	0
B.5	Violence and terrorism	33%	11%	76%	–86%	173%	0	0	–183%	270%	0	0
B.6	Ability to appoint expatriates	25%	14%	65%	–63%	142%	0	0	–140%	219%	0	0
B.7	Procurement of local and foreign materials, services, and equipment	50%	18%	63%	–48%	129%	0	0	–114%	195%	0	0
B.8	Country infrastructure (power, roads, rail, water ports)	50%	18%	62%	–47%	127%	0	0	–112%	193%	0	0
B.9	Custom duties & logistic routes	33%	20%	68%	–53%	141%	0	0	–125%	213%	0	0

Annexure I (Continued)– Identification of outliers and extremes

C	PROJECT FEASIBILITY											
C.1	Resources secured (including land and mineral rights)	57%	33%	100%	–67%	200%	0	0	–167%	300%	0	0
C.2	Financing secured (Internal, external, equity, debt)	42%	29%	80%	–47%	156%	0	0	–123%	232%	0	0
C.3	Business Plan	33%	29%	70%	–32%	131%	0	0	–93%	192%	0	0
C.4	Economic Analysis	50%	32%	59%	–10%	100%	0	0	–51%	142%	0	0
C.5	Affordability / Feasibility	50%	32%	71%	–27%	129%	0	0	–85%	188%	0	0
C.6	Contingencies (Capex & Opex)	60%	50%	100%	–25%	175%	0	0	–100%	250%	0	0
C.7	Basis of Estimate	40%	33%	63%	–10%	106%	0	0	–54%	150%	0	0
C.8	Scenario planning	40%	18%	50%	–29%	98%	0	0	–77%	145%	0	0
D	RESOURCE AND RESERVE STATEMENT											
D.1	Metallurgical yield	65%	35%	100%	–63%	198%	0	0	–160%	295%	0	0
D.2	Reserve risks (including modifying factors)	67%	44%	100%	–41%	184%	0	0	–125%	269%	0	0
D.3	Grade engineering / control	48%	26%	65%	–32%	123%	0	0	–90%	181%	0	0
D.4	Prospect drilling standard / guideline	43%	26%	65%	–33%	124%	0	0	–91%	182%	0	0
D.5	Geological conditions (Geological model, structure, qualities)	55%	45%	80%	–8%	133%	0	0	–61%	186%	0	0
D.6	Hydrogeology	46%	26%	50%	–9%	86%	0	0	–45%	121%	0	0
E	LIFE OF MINE PLANNING											
E.1	Mine design criteria	50%	31%	59%	–10%	100%	0	0	–52%	141%	0	0
E.2	Shaft/ramp design & men and material logistics	43%	26%	57%	–20%	103%	0	0	–67%	149%	0	0
E.3	Mining methods (drilling, blasting, loading, hauling)	42%	28%	54%	–11%	93%	0	1	–50%	131%	0	0

Annexure I (Continued)– Identification of outliers and extremes

E	**LIFE OF MINE PLANNING**											
E.4	Equipment selection to fit geological conditions and mining method	33%	25%	58%	–24%	107%	0	0	–73%	156%	0	0
E.5	Life–of–mine plan	35%	23%	54%	–25%	102%	0	0	–73%	149%	0	0
E.6	Waste management plan	30%	21%	50%	–23%	94%	0	1	–67%	138%	0	0
E.7	Ultimate pit limits designed	33%	17%	50%	–32%	99%	0	1	–81%	149%	0	0
E.8	Economic block values determination	50%	32%	63%	–16%	111%	0	0	–63%	158%	0	0
E.9	Beneficiation facilities LOM plan	43%	29%	52%	–5%	85%	0	2	–38%	119%	0	0
E.10	Materials handling LOM plan	40%	23%	57%	–29%	109%	0	0	–81%	161%	0	0
F	**OPERATING PHILOSOPHY**											
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	29%	15%	45%	–30%	90%	0	1	–74%	135%	0	0
F.2	Productivity / efficiency benchmarks	27%	14%	45%	–33%	92%	0	0	–80%	139%	0	0
F.3	Operating costs	57%	46%	68%	14%	101%	0	0	–19%	134%	0	0
F.4	Production risks	50%	38%	63%	–1%	102%	0	0	–40%	141%	0	0
F.5	Catalogue of operating plans	25%	13%	41%	–29%	84%	0	0	–71%	126%	0	0
F.6	Haul roads	33%	15%	52%	–39%	106%	0	0	–93%	160%	0	0
F.7	Transportation strategy	33%	27%	43%	2%	68%	0	1	–23%	93%	0	0
F.8	Contractual considerations	33%	23%	42%	–5%	71%	0	0	–33%	99%	0	1
G	**MARKET ANALYSIS AND STRATEGY**											
G.1	Market Strategy & Sales Agreements	50%	25%	68%	–40%	133%	0	0	–105%	198%	0	0
G.2	Price risks	60%	36%	77%	–25%	139%	0	0	–87%	201%	0	0
G.3	Demand risks & replacement products / technologies	50%	28%	76%	–46%	149%	0	0	–119%	222%	0	0

Annexure I (Continued)– Identification of outliers and extremes

G	MARKET ANALYSIS AND STRATEGY											
G.4	Value–Analysis Process	30%	24%	45%	–7%	76%	0	0	–38%	108%	0	0
G.5	Hedging	20%	14%	40%	–25%	79%	0	0	–65%	119%	0	0
G.6	Competitor analysis	17%	14%	35%	–18%	67%	0	1	–50%	99%	0	0

	SECTION II – PROJECT DETAILS	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
H	PROJECT CONSIDERATIONS																			
H.1	Expected Project Life Cycle	100%	25%	25%	70%	10%	71%	86%	50%	33%	16%	20%	57%	47%	13%	33%	60%	10%	33%	50%
H.2	Assumption register	60%	10%	25%	30%	30%	14%	29%	50%	17%	10%	10%	43%	33%	13%	25%	20%	70%	67%	58%
H.3	Completion risks	70%	35%	25%	50%	30%	14%	29%	50%	33%	12%	13%	57%	40%	13%	42%	30%	70%	33%	75%
H.4	Project Design Criteria	80%	25%	25%	70%	30%	14%	86%	70%	17%	20%	17%	71%	27%	13%	50%	50%	70%	67%	92%
H.5	Scope of Work Overview	80%	35%	100%	70%	50%	14%	86%	100%	50%	20%	33%	86%	33%	67%	50%	60%	70%	100%	83%
H.6	Project Schedule	100%	50%	100%	70%	50%	71%	71%	70%	67%	20%	33%	86%	67%	67%	75%	60%	70%	100%	67%
H.7	Project Cost Estimate	100%	100%	100%	50%	70%	71%	71%	70%	67%	20%	33%	100%	53%	100%	83%	60%	70%	100%	58%
H.8	Investment Studies & Alternatives Assessments	70%	75%	50%	50%	10%	29%	43%	50%	33%	40%	27%	29%	27%	27%	25%	50%	70%	53%	33%
H.9	Key Team Member Coordination	70%	10%	50%	50%	8%	29%	43%	50%	67%	12%	13%	57%	13%	13%	17%	30%	70%	33%	42%
H.10	Evaluation of Compliance Requirements	80%	25%	40%	70%	6%	43%	71%	100%	50%	40%	10%	86%	13%	13%	33%	50%	70%	33%	33%
H.11	Lead / Discipline Scope of Work	80%	10%	75%	50%	10%	14%	71%	50%	50%	12%	10%	71%	20%	33%	50%	50%	70%	67%	50%
H.12	Housing and transport of employees	100%	15%	50%	50%	8%	14%	43%	50%	33%	16%	10%	29%	13%	20%	8%	20%	70%	33%	58%

Annexure I (Continued)– Identification of outliers and extremes

H	**PROJECT CONSIDERATIONS**																			
H.13	Risk or impact on other projects / divisions	70%	5%	25%	50%	10%	14%	29%	50%	33%	12%	17%	29%	13%	13%	8%	20%	70%	53%	83%
I	**PROJECT SCOPE**																			
I.1	Project Objectives Statement	70%	15%	50%	60%	6%	29%	100%	50%	50%	16%	17%	14%	13%	20%	17%	50%	100%	67%	25%
I.2	Site Characteristics Available vs. Required	70%	15%	25%	50%	10%	29%	86%	50%	33%	10%	20%	20%	13%	13%	42%	40%	70%	67%	42%
I.3	Project Scope Definition	90%	25%	75%	70%	40%	71%	100%	50%	50%	20%	27%	86%	27%	67%	50%	50%	80%	100%	58%
I.4	WBS and WBS Dictionary	80%	25%	50%	50%	20%	71%	100%	50%	33%	20%	33%	86%	27%	33%	67%	50%	70%	100%	50%
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																			
J.1	Unique mine closure plan	70%	25%	50%	50%	6%	14%	29%	40%	33%	10%	50%	29%	13%	33%	50%	16%	40%	33%	58%
J.2	Land use plan post operations	70%	15%	40%	40%	6%	14%	14%	40%	17%	10%	50%	14%	13%	13%	83%	16%	40%	33%	50%
J.3	Social expectations register	70%	15%	40%	60%	10%	14%	23%	40%	33%	10%	67%	43%	13%	13%	33%	20%	40%	33%	58%
J.4	Relocation Action Plan	90%	25%	40%	80%	10%	100%	86%	40%	50%	20%	100%	86%	13%	33%	33%	20%	40%	53%	42%
J.5	Environmental expectations register	80%	25%	25%	50%	16%	43%	57%	40%	33%	20%	43%	43%	13%	20%	25%	30%	40%	33%	25%
J.6	Political expectations register	100%	15%	25%	50%	16%	14%	23%	40%	67%	12%	50%	57%	13%	13%	33%	20%	40%	33%	33%
J.7	Legal compliance register	80%	35%	50%	50%	8%	100%	71%	60%	50%	16%	40%	43%	13%	33%	33%	20%	40%	53%	67%
J.8	HSE risk register	80%	25%	25%	40%	6%	14%	51%	60%	33%	20%	27%	29%	13%	33%	33%	30%	40%	53%	33%
J.9	Community risk register	70%	25%	25%	50%	16%	29%	43%	60%	67%	12%	67%	43%	13%	33%	42%	20%	40%	53%	67%
J.10	Business risk register	70%	25%	25%	50%	16%	14%	57%	60%	33%	14%	23%	29%	13%	33%	25%	30%	40%	53%	42%

Annexure I (Continued)– Identification of outliers and extremes

J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**																			
J.11	Developmental opportunity register	70%	15%	25%	50%	6%	14%	29%	40%	17%	6%	47%	57%	13%	33%	17%	30%	40%	33%	50%
J.12	Sustainability operating plan	70%	15%	50%	50%	6%	14%	29%	50%	33%	12%	27%	43%	13%	33%	33%	20%	40%	33%	33%
J.13	Stakeholder engagement plan	90%	15%	50%	50%	10%	14%	29%	50%	33%	14%	53%	29%	13%	33%	33%	20%	40%	67%	33%
J.14	Mine closure financial provision plan	90%	25%	50%	50%	30%	14%	29%	60%	17%	8%	50%	86%	13%	33%	8%	30%	40%	33%	75%
J.15	Closure plan review and updates scheduled during Life of Mine plan	80%	15%	50%	40%	20%	14%	29%	60%	17%	8%	30%	29%	13%	33%	17%	20%	40%	53%	33%
J.16	Social investment plan	70%	10%	50%	60%	6%	14%	23%	40%	33%	12%	47%	86%	13%	33%	33%	20%	40%	33%	50%
J.17	Economic diversification plan	70%	10%	50%	50%	4%	14%	14%	40%	33%	8%	33%	86%	13%	33%	25%	20%	40%	33%	42%
J.18	Existing Environmental Conditions	80%	25%	50%	50%	14%	14%	14%	40%	17%	10%	27%	43%	13%	33%	33%	30%	40%	33%	50%
J.19	Environmental Process determined	70%	25%	50%	50%	16%	14%	23%	40%	33%	12%	33%	29%	13%	33%	25%	30%	40%	33%	50%
J.20	Environmental management plan	70%	25%	50%	50%	24%	14%	14%	40%	33%	12%	40%	71%	13%	33%	100%	30%	40%	53%	33%

	SECTION II – PROJECT DETAILS	**Median**	**Q1**	**Q3**	**Lower**	**Higher**	**Lower count**	**Upper count**	**Lower**	**Higher**	**Lower count**	**Upper count**
H	**PROJECT CONSIDERATIONS**											
H.1	Expected Project Life Cycle	33%	23%	59%	–32%	113%	0	0	–86%	167%	0	0
H.2	Assumption register	29%	15%	46%	–31%	93%	0	0	–77%	139%	0	0
H.3	Completion risks	33%	27%	50%	–8%	85%	0	0	–43%	120%	0	0
H.4	Project Design Criteria	50%	23%	70%	–49%	141%	0	0	–120%	213%	0	0
H.5	Scope of Work Overview	67%	43%	85%	–21%	148%	0	0	–84%	211%	0	0

Annexure I (Continued)– Identification of outliers and extremes

H	**PROJECT CONSIDERATIONS**											
H.6	Project Schedule	70%	63%	73%	49%	88%	0	3	34%	103%	2	0
H.7	Project Cost Estimate	70%	59%	100%	–2%	161%	0	0	–63%	223%	0	0
H.8	Investment Studies & Alternatives Assessments	40%	28%	50%	–6%	84%	0	0	–40%	117%	0	0
H.9	Key Team Member Coordination	33%	13%	50%	–42%	105%	0	0	–97%	160%	0	0
H.10	Evaluation of Compliance Requirements	40%	29%	70%	–32%	131%	0	0	–93%	193%	0	0
H.11	Lead / Discipline Scope of Work	50%	17%	68%	–60%	145%	0	0	–136%	222%	0	0
H.12	Housing and transport of employees	29%	15%	50%	–38%	103%	0	0	–91%	156%	0	0
H.13	Risk or impact on other projects / divisions	25%	13%	50%	–42%	105%	0	0	–97%	160%	0	0
I	**PROJECT SCOPE**											
I.1	Project Objectives Statement	29%	16%	55%	–42%	113%	0	0	–100%	171%	0	0
I.2	Site Characteristics Available vs. Required	33%	18%	50%	–31%	99%	0	0	–80%	148%	0	0
I.3	Project Scope Definition	58%	45%	78%	–4%	126%	0	0	–53%	175%	0	0
I.4	WBS and WBS Dictionary	50%	33%	71%	–23%	127%	0	0	–79%	183%	0	0
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**											
J.1	Unique mine closure plan	33%	21%	50%	–24%	94%	0	0	–68%	139%	0	0
J.2	Land use plan post operations	17%	14%	40%	–24%	79%	0	1	–63%	117%	0	0
J.3	Social expectations register	33%	15%	41%	–26%	82%	0	0	–66%	122%	0	0
J.4	Relocation Action Plan	40%	29%	83%	–51%	163%	0	0	–132%	244%	0	0
J.5	Environmental expectations register	33%	25%	43%	–2%	70%	0	1	–29%	96%	0	0
J.6	Political expectations register	33%	16%	45%	–29%	89%	0	1	–73%	134%	0	0

Annexure I (Continued)– Identification of outliers and extremes

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS											
J.7	Legal compliance register	43%	33%	57%	–2%	92%	0	1	–37%	127%	0	0
J.8	HSE risk register	33%	25%	40%	3%	63%	0	1	–20%	85%	0	0
J.9	Community risk register	42%	25%	57%	–23%	104%	0	0	–70%	152%	0	0
J.10	Business risk register	30%	24%	46%	–8%	78%	0	0	–41%	111%	0	0
J.11	Developmental opportunity register	30%	16%	43%	–25%	85%	0	0	–67%	126%	0	0
J.12	Sustainability operating plan	33%	18%	41%	–18%	77%	0	0	–54%	113%	0	0
J.13	Stakeholder engagement plan	33%	18%	50%	–31%	99%	0	0	–80%	148%	0	0
J.14	Mine closure financial provision plan	33%	21%	50%	–23%	94%	0	0	–67%	138%	0	0
J.15	Closure plan review and updates scheduled during Life of Mine plan	29%	17%	40%	–18%	75%	0	1	–53%	110%	0	0
J.16	Social investment plan	33%	17%	48%	–30%	95%	0	0	–76%	142%	0	0
J.17	Economic diversification plan	33%	14%	41%	–26%	81%	0	1	–65%	120%	0	0
J.18	Existing Environmental Conditions	33%	15%	41%	–23%	80%	0	0	–62%	119%	0	0
J.19	Environmental Process determined	33%	24%	40%	0%	64%	0	1	–24%	88%	0	0
J.20	Environmental management plan	33%	25%	50%	–14%	88%	0	1	–52%	127%	0	0

SECTION III – DESIGN FOR CONSTRUCTION		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
K	SITE INFORMATION																			
K.1	Site Layout	80%	35%	25%	50%	10%	43%	29%	100%	17%	10%	17%	29%	20%	33%	33%	50%	80%	53%	42%
K.2	Site Surveys	80%	25%	25%	50%	10%	43%	14%	100%	17%	10%	20%	43%	33%	33%	25%	40%	80%	33%	33%
K.3	Governing Regulatory Requirements	100%	10%	50%	70%	10%	71%	57%	60%	33%	10%	20%	14%	13%	33%	25%	40%	80%	53%	50%

Annexure I (Continued)– Identification of outliers and extremes

K	**SITE INFORMATION**																			
K.4	Utility Sources with Supply Conditions	90%	25%	25%	60%	10%	57%	71%	50%	17%	10%	23%	14%	13%	33%	33%	40%	100%	33%	58%
K.5	Fire Protection, emergency procedure & Safety Considerations	60%	25%	50%	50%	10%	14%	29%	40%	17%	8%	17%	29%	13%	33%	17%	40%	10%	33%	75%
K.6	Special Water and Waste Treatment Requirements	70%	30%	25%	50%	10%	14%	29%	50%	33%	8%	17%	14%	13%	33%	25%	40%	100%	33%	58%
K.7	Property Descriptions	60%	10%	25%	40%	10%	6%	23%	40%	17%	6%	10%	0%	13%	33%	17%	20%	10%	27%	33%
K.8	Right–of–Way Mapping & Site Issues	70%	20%	25%	50%	12%	6%	23%	60%	17%	10%	13%	6%	13%	33%	17%	40%	100%	33%	25%
K.9	Land Rights	100%	35%	50%	70%	18%	57%	43%	100%	50%	12%	27%	14%	13%	33%	25%	40%	100%	67%	42%
L	**PROJECT DESIGN PARAMETERS**																			
L.1	Design Criteria	80%	35%	50%	70%	6%	9%	29%	60%	17%	16%	33%	43%	33%	33%	25%	50%	70%	53%	33%
L.2	Civil/Site Design	70%	50%	50%	50%	16%	9%	43%	60%	33%	12%	27%	29%	33%	33%	33%	50%	70%	33%	42%
L.3	Geotechnical investigation for structures	70%	50%	35%	50%	10%	71%	43%	60%	33%	20%	43%	14%	33%	33%	50%	50%	70%	33%	50%
L.4	Architectural Design	60%	25%	35%	40%	6%	9%	29%	60%	17%	12%	13%	14%	33%	13%	33%	50%	70%	27%	58%
L.5	Structural Design	70%	30%	50%	60%	12%	9%	57%	60%	33%	12%	13%	29%	33%	33%	50%	50%	70%	33%	42%
L.6	Mechanical Design	70%	30%	50%	60%	16%	9%	57%	60%	33%	12%	13%	29%	33%	33%	25%	50%	70%	33%	58%
L.7	Electrical Design	70%	40%	50%	60%	10%	9%	43%	60%	33%	12%	13%	29%	33%	33%	67%	50%	70%	33%	75%
L.8	Constructability Analysis	80%	50%	30%	60%	20%	9%	71%	60%	33%	12%	40%	43%	33%	33%	50%	40%	70%	27%	50%
L.9	Process Design	100%	75%	50%	50%	30%	71%	86%	60%	50%	20%	47%	57%	33%	33%	33%	40%	70%	67%	58%
L.10	Specifications	80%	35%	50%	50%	10%	9%	23%	60%	33%	12%	17%	29%	33%	33%	50%	50%	70%	33%	67%
L.11	Specialty Items List	60%	15%	25%	50%	4%	9%	29%	60%	17%	12%	13%	29%	33%	33%	33%	50%	70%	20%	92%
L.12	Instrument Index	70%	50%	50%	50%	6%	9%	23%	60%	8%	10%	27%	14%	33%	33%	33%	30%	70%	20%	67%
L.13	Control Philosophy & systems	70%	40%	50%	50%	10%	9%	23%	60%	50%	10%	33%	29%	33%	33%	50%	30%	70%	27%	92%
L.14	Logic Diagrams	70%	40%	50%	50%	4%	9%	23%	60%	17%	10%	27%	14%	33%	33%	50%	30%	70%	20%	67%

Annexure I (Continued)– Identification of outliers and extremes

L	**PROJECT DESIGN PARAMETERS**																			
L.15	IM (information management)	70%	25%	50%	50%	6%	9%	43%	60%	17%	10%	33%	3%	33%	33%	42%	30%	70%	20%	42%
L.16	Control of Access	60%	25%	50%	50%	2%	9%	29%	60%	17%	8%	17%	14%	33%	33%	17%	20%	70%	13%	50%
L.17	Safety & Hazards	60%	50%	50%	50%	4%	9%	29%	60%	33%	12%	33%	14%	33%	33%	50%	30%	70%	20%	50%
L.18	Operations/Maintenance	60%	25%	50%	50%	12%	9%	23%	60%	33%	12%	23%	14%	33%	33%	67%	40%	70%	53%	75%
L.19	Ventilation Engineering	80%	25%	40%	50%	6%	9%	29%	60%	17%	40%	27%	29%	33%	33%	33%	30%	70%	53%	75%
L.20	Rock Engineering	80%	50%	40%	50%	16%	9%	29%	60%	8%	40%	40%	29%	33%	33%	67%	40%	70%	40%	42%
L.21	Water balances	80%	35%	40%	50%	12%	43%	29%	60%	33%	12%	33%	14%	33%	33%	50%	40%	70%	40%	58%
L.22	Energy efficiency / carbon footprint	60%	25%	40%	50%	4%	43%	14%	60%	17%	10%	17%	3%	33%	13%	67%	20%	70%	33%	50%
L.23	Tailings handling and storage	80%	50%	40%	50%	18%	43%	29%	60%	33%	30%	20%	43%	33%	53%	50%	20%	70%	33%	83%
L.24	Stormwater handling / surface hydrology	80%	50%	40%	50%	12%	43%	14%	60%	17%	12%	17%	29%	33%	33%	42%	20%	70%	27%	58%
L.25	Internal technical audits	60%	15%	40%	40%	4%	9%	9%	60%	50%	8%	20%	3%	33%	33%	25%	20%	70%	13%	25%
L.26	External technical audits	60%	15%	40%	40%	4%	9%	9%	60%	17%	8%	20%	3%	33%	13%	33%	30%	70%	13%	58%
M	**VALUE IMPROVING PRACTICES**																			
M.1	Process Simplification	70%	25%	25%	50%	6%	9%	57%	40%	17%	4%	27%	14%	33%	13%	67%	50%	0%	27%	50%
M.2	Design & Material Alternatives Considered/Rejected	70%	20%	25%	40%	6%	9%	29%	30%	33%	4%	27%	14%	27%	13%	50%	50%	50%	27%	42%
M.3	Technology trends	70%	25%	38%	40%	6%	9%	23%	30%	33%	4%	23%	14%	20%	13%	50%	40%	50%	20%	67%
M.4	Design to capacity	70%	40%	50%	50%	8%	9%	29%	40%	33%	4%	27%	14%	13%	13%	25%	30%	50%	27%	33%
M.5	Classes of facility quality	70%	15%	25%	50%	4%	9%	29%	30%	17%	8%	23%	29%	13%	13%	33%	40%	0%	13%	25%
M.6	Energy optimisation	60%	15%	25%	40%	4%	9%	23%	30%	33%	4%	30%	43%	20%	13%	33%	40%	0%	13%	42%
M.7	Waste minimisation	60%	20%	38%	40%	10%	9%	29%	50%	33%	4%	30%	14%	13%	13%	33%	40%	0%	27%	58%
M.8	3D / 4D design	60%	40%	50%	50%	6%	9%	57%	20%	17%	4%	30%	29%	40%	13%	50%	30%	0%	20%	42%
M.9	Cleaner Production	70%	15%	25%	50%	4%	9%	29%	30%	33%	4%	27%	29%	27%	13%	17%	30%	0%	13%	67%

Annexure I (Continued)– Identification of outliers and extremes

M	**VALUE IMPROVING PRACTICES**																			
M.10	Innovation and knowledge management planning	60%	20%	38%	40%	2%	9%	29%	20%	17%	4%	33%	14%	33%	13%	50%	30%	0%	27%	33%
M.11	Six Sigma	60%	20%	25%	50%	2%	9%	29%	10%	8%	4%	37%	29%	33%	13%	33%	30%	0%	27%	42%
M.12	Lean Manufacturing	60%	25%	25%	40%	2%	9%	23%	10%	8%	4%	27%	14%	33%	13%	50%	30%	0%	20%	42%

SECTION III – DESIGN FOR CONSTRUCTION		**Median**	**Q1**	**Q3**	**Lower**	**Higher**	**Lower count**	**Upper count**	**Lower**	**Higher**	**Lower count**	**Upper count**
K	**SITE INFORMATION**											
K.1	Site Layout	33%	23%	50%	–19%	91%	0	1	–60%	133%	0	0
K.2	Site Surveys	33%	23%	43%	–8%	73%	0	3	–39%	104%	0	0
K.3	Governing Regulatory Requirements	40%	17%	59%	–45%	121%	0	0	–107%	183%	0	0
K.4	Utility Sources with Supply Conditions	33%	20%	58%	–37%	114%	0	0	–93%	171%	0	0
K.5	Fire Protection, emergency procedure & Safety Considerations	29%	15%	40%	–21%	77%	0	0	–58%	114%	0	0
K.6	Special Water and Waste Treatment Requirements	30%	15%	45%	–29%	89%	0	1	–73%	134%	0	0
K.7	Property Descriptions	17%	10%	30%	–20%	60%	0	0	–50%	90%	0	0
K.8	Right–of–Way Mapping & Site Issues	23%	13%	37%	–22%	72%	0	1	–57%	107%	0	0
K.9	Land Rights	42%	26%	62%	–28%	116%	0	0	–82%	170%	0	0
L	**PROJECT DESIGN PARAMETERS**											
L.1	Design Criteria	33%	27%	52%	–11%	89%	0	0	–48%	126%	0	0
L.2	Civil/Site Design	33%	31%	50%	2%	79%	0	0	–26%	107%	0	0
L.3	Geotechnical investigation for structures	43%	33%	50%	8%	75%	0	0	–17%	100%	0	0
L.4	Architectural Design	29%	14%	45%	–33%	92%	0	0	–80%	139%	0	0

Annexure I (Continued)– Identification of outliers and extremes

L	**PROJECT DESIGN PARAMETERS**											
L.5	Structural Design	33%	29%	54%	–7%	90%	0	0	–44%	126%	0	0
L.6	Mechanical Design	33%	27%	58%	–20%	104%	0	0	–66%	151%	0	0
L.7	Electrical Design	40%	31%	60%	–13%	104%	0	0	–56%	147%	0	0
L.8	Constructability Analysis	40%	32%	55%	–3%	90%	0	0	–38%	125%	0	0
L.9	Process Design	50%	37%	68%	–11%	116%	0	0	–58%	163%	0	0
L.10	Specifications	33%	26%	50%	–11%	86%	0	0	–47%	123%	0	0
L.11	Specialty Items List	29%	16%	50%	–35%	101%	0	0	–87%	153%	0	0
L.12	Instrument Index	33%	17%	50%	–32%	99%	0	0	–81%	149%	0	0
L.13	Control Philosophy & systems	33%	28%	50%	–6%	84%	0	1	–40%	117%	0	0
L.14	Logic Diagrams	33%	18%	50%	–29%	98%	0	0	–77%	145%	0	0
L.15	IM (information management)	33%	18%	46%	–24%	89%	0	0	–66%	131%	0	0
L.16	Control of Access	25%	15%	50%	–36%	102%	0	0	–88%	154%	0	0
L.17	Safety & Hazards	33%	24%	50%	–14%	89%	0	0	–53%	127%	0	0
L.18	Operations/Maintenance	33%	23%	57%	–27%	107%	0	0	–78%	157%	0	0
L.19	Ventilation Engineering	33%	28%	52%	–8%	88%	0	0	–45%	124%	0	0
L.20	Rock Engineering	40%	31%	50%	2%	79%	0	1	–26%	107%	0	0
L.21	Water balances	40%	33%	50%	8%	75%	0	1	–17%	100%	0	0
L.22	Energy efficiency / carbon footprint	33%	15%	50%	–36%	102%	0	0	–88%	154%	0	0
L.23	Tailings handling and storage	43%	32%	52%	2%	82%	0	1	–28%	112%	0	0
L.24	Stormwater handling / surface hydrology	33%	18%	50%	–29%	98%	0	0	–77%	145%	0	0
L.25	Internal technical audits	25%	11%	40%	–33%	84%	0	0	–76%	127%	0	0
L.26	External technical audits	20%	11%	40%	–33%	84%	0	0	–76%	127%	0	0
M	**VALUE IMPROVING PRACTICES**											
M.1	Process Simplification	27%	14%	50%	–40%	104%	0	0	–95%	159%	0	0
M.2	Design & Material Alternatives Considered/Rejected	27%	17%	41%	–18%	76%	0	0	–54%	112%	0	0

Annexure I (Continued)– Identification of outliers and extremes

M	VALUE IMPROVING PRACTICES											
M.3	Technology trends	25%	17%	40%	–17%	74%	0	0	–51%	109%	0	0
M.4	Design to capacity	29%	14%	40%	–25%	79%	0	0	–65%	119%	0	0
M.5	Classes of facility quality	23%	13%	29%	–11%	53%	0	1	–35%	77%	0	0
M.6	Energy optimisation	25%	13%	37%	–22%	72%	0	0	–57%	107%	0	0
M.7	Waste minimisation	29%	13%	39%	–25%	77%	0	0	–63%	115%	0	0
M.8	3D / 4D design	30%	15%	46%	–31%	92%	0	0	–78%	138%	0	0
M.9	Cleaner Production	27%	13%	30%	–12%	55%	0	2	–37%	80%	0	0
M.10	Innovation and knowledge management planning	27%	14%	33%	–15%	63%	0	0	–45%	92%	0	0
M.11	Six Sigma	27%	9%	33%	–27%	69%	0	0	–63%	105%	0	0
M.12	Lean Manufacturing	23%	9%	32%	–24%	65%	0	0	–58%	99%	0	0

Annexure I (Continued)– Identification of outliers and extremes

SECTION IV – IMPLEMENTATION APPROACH		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19
N	PROCUREMENT STRATEGY																			
N.1	Identify Long Lead/Critical Equipment and Materials	80%	35%	38%	70%	16%	43%	14%	20%	50%	10%	33%	43%	13%	33%	33%	40%	100%	33%	50%
N.2	Procurement Procedures and Plans	80%	25%	50%	50%	12%	29%	14%	30%	33%	10%	27%	29%	27%	33%	17%	50%	20%	27%	25%
N.3	Procurement Responsibility Matrix	70%	25%	50%	60%	4%	9%	11%	20%	17%	6%	23%	29%	20%	33%	17%	40%	20%	20%	8%
N.4	Draft contracts & proforma bidders pack	80%	35%	50%	50%	8%	9%	20%	30%	33%	6%	23%	43%	47%	33%	8%	30%	20%	27%	42%
N.5	Contracting strategy	90%	35%	38%	60%	16%	14%	20%	60%	33%	10%	27%	43%	47%	33%	17%	40%	50%	33%	83%
N.6	Procurement operation plan (POP)	80%	35%	50%	50%	8%	29%	23%	40%	33%	10%	27%	29%	33%	33%	25%	40%	20%	33%	67%
O	DELIVERABLES																			
O.1	CADD/Model Requirements	80%	15%	38%	40%	4%	9%	14%	30%	17%	8%	20%	29%	33%	20%	50%	30%	30%	27%	42%
O.2	Deliverables Defined	80%	40%	50%	60%	2%	9%	29%	40%	33%	12%	23%	71%	47%	20%	33%	50%	50%	27%	50%
O.3	Distribution Matrix	60%	10%	38%	40%	0%	9%	23%	30%	17%	8%	20%	14%	27%	20%	33%	30%	10%	20%	33%
O.4	Documentation/Deliverables	70%	40%	38%	50%	2%	29%	14%	30%	17%	8%	17%	6%	40%	20%	25%	40%	30%	20%	58%
P	PROJECT CONTROLS																			
P.1	Project Quality Assurance and Control	80%	25%	50%	50%	4%	57%	43%	40%	33%	10%	17%	43%	47%	20%	17%	40%	70%	27%	25%
P.2	Project Cost Control	90%	25%	50%	50%	6%	100%	29%	40%	83%	8%	23%	86%	20%	20%	42%	40%	70%	27%	50%
P.3	Project Schedule Control	90%	30%	50%	50%	10%	100%	43%	40%	83%	8%	23%	71%	27%	20%	50%	40%	70%	40%	50%
P.4	Risk Management	80%	40%	75%	50%	10%	43%	29%	40%	33%	8%	27%	43%	40%	20%	25%	40%	70%	27%	58%
P.5	Safety, Health, Hygiene and security Management	60%	40%	50%	50%	10%	100%	14%	40%	100%	10%	17%	29%	33%	20%	17%	40%	50%	40%	67%
P.6	Environmental Management	80%	40%	25%	50%	10%	43%	14%	40%	50%	8%	17%	29%	13%	20%	33%	40%	70%	27%	75%
P.7	Project Change Control	100%	50%	38%	50%	12%	100%	43%	40%	50%	10%	17%	86%	20%	20%	67%	40%	70%	33%	67%
P.8	Project Audits	60%	35%	25%	50%	4%	14%	17%	40%	8%	8%	13%	29%	13%	20%	17%	30%	70%	27%	33%
P.9	Decision register	90%	50%	25%	50%	8%	14%	46%	40%	33%	8%	13%	43%	13%	20%	17%	20%	70%	40%	58%
Q	PROJECT IMPLEMENTATION PLAN																			
Q.1	Engineering / Construction Plan & Approach	90%	50%	50%	50%	20%	14%	57%	40%	50%	12%	23%	43%	33%	20%	42%	50%	50%	40%	67%
Q.2	Project Organization	60%	50%	38%	50%	10%	14%	57%	40%	67%	16%	30%	57%	60%	20%	17%	40%	50%	33%	33%

Annexure I (Continued)– Identification of outliers and extremes

Q.3	Responsibility matrix RACI	70%	40%	38%	50%	4%	14%	43%	40%	33%	12%	30%	29%	33%	20%	17%	40%	40%	53%	25%
Q.4	Document Management Plan	60%	25%	25%	50%	2%	14%	23%	40%	17%	8%	13%	14%	27%	20%	8%	40%	30%	33%	17%
Q.5	Communication management plan	70%	35%	25%	50%	2%	14%	17%	40%	33%	8%	17%	14%	27%	20%	17%	40%	70%	33%	17%
Q.6	Project Delivery Method	80%	40%	25%	60%	16%	14%	23%	40%	50%	12%	30%	29%	47%	20%	33%	50%	50%	40%	42%
Q.7	Design / Construction Plan and Approach	80%	40%	50%	50%	12%	14%	86%	40%	50%	12%	30%	43%	47%	20%	17%	40%	50%	33%	33%
Q.8	Safety Procedures	70%	40%	50%	50%	8%	14%	23%	40%	50%	12%	17%	29%	33%	20%	33%	30%	10%	27%	67%
Q.9	Intercompany Agreements	80%	40%	25%	40%	4%	14%	14%	40%	33%	8%	13%	14%	13%	20%	17%	20%	50%	27%	42%
Q.10	Deliverables for Design and Construction	80%	40%	38%	50%	14%	71%	57%	40%	50%	6%	23%	71%	27%	20%	33%	50%	50%	27%	75%
Q.11	Labour and Skilled resources plan	90%	40%	25%	50%	24%	29%	29%	40%	50%	6%	33%	43%	27%	20%	17%	40%	100%	27%	58%
R	**HANDOVER & OPERATIONAL READINESS**																			
R.1	Commissioning plan	80%	50%	50%	50%	8%	71%	43%	40%	67%	8%	30%	43%	33%	20%	25%	40%	50%	33%	33%
R.2	Start–up Requirements & plans	70%	40%	38%	50%	6%	43%	57%	40%	50%	8%	33%	71%	27%	20%	17%	40%	50%	27%	25%
R.3	Training Requirements	70%	25%	38%	50%	4%	43%	43%	60%	17%	8%	30%	29%	13%	20%	17%	40%	50%	27%	42%
R.4	Substantial Completion Requirements	70%	25%	38%	50%	4%	43%	43%	40%	17%	8%	30%	57%	27%	20%	25%	40%	50%	33%	42%
R.5	Deliverables for Project Commissioning / Closeout	80%	30%	38%	50%	4%	29%	71%	40%	33%	8%	20%	43%	27%	20%	17%	40%	50%	27%	58%
R.6	Long term supply chain contracts	80%	30%	25%	50%	4%	14%	29%	70%	50%	8%	30%	29%	13%	20%	17%	40%	50%	33%	42%
R.7	Resourcing & staffing for operation	80%	30%	25%	50%	8%	43%	29%	70%	33%	10%	33%	29%	13%	20%	8%	40%	50%	27%	50%
R.8	Maintenance schedules	70%	25%	25%	50%	4%	14%	20%	70%	17%	10%	23%	29%	13%	20%	25%	20%	50%	27%	33%
R.9	Critical spares	80%	25%	38%	50%	6%	14%	20%	50%	17%	8%	20%	43%	13%	20%	17%	30%	50%	33%	33%
R.10	Start–up consumables	70%	25%	25%	50%	2%	14%	23%	40%	33%	8%	27%	29%	13%	20%	25%	20%	50%	20%	42%
R.11	Operational systems and procedures to support each department	80%	25%	38%	50%	6%	9%	51%	60%	33%	8%	27%	14%	13%	20%	33%	20%	50%	27%	25%
R.12	Environmental Management Plan for Operations (EMP)	70%	25%	38%	50%	6%	43%	43%	60%	50%	8%	23%	43%	13%	20%	50%	50%	50%	27%	42%

Annexure I (Continued)– Identification of outliers and extremes

SECTION IV – IMPLEMENTATION APPROACH		Median	Q1	Q3	Lower	Higher	Lower count	Upper count	Lower	Higher	Lower count	Upper count
N	PROCUREMENT STRATEGY											
N.1	Identify Long Lead/Critical Equipment and Materials	35%	27%	46%	–3%	76%	0	2	–33%	106%	0	0
N.2	Procurement Procedures and Plans	27%	23%	33%	6%	50%	0	3	–10%	66%	0	1
N.3	Procurement Responsibility Matrix	20%	14%	31%	–11%	56%	0	2	–37%	82%	0	0
N.4	Draft contracts & proforma bidders pack	30%	20%	42%	–13%	76%	0	1	–47%	109%	0	0
N.5	Contracting strategy	35%	23%	48%	–14%	86%	0	1	–52%	123%	0	0
N.6	Procurement operation plan (POP)	33%	26%	40%	5%	61%	0	2	–17%	83%	0	0
O	DELIVERABLES											
O.1	CADD/Model Requirements	29%	16%	35%	–14%	65%	0	1	–43%	94%	0	0
O.2	Deliverables Defined	40%	25%	50%	–13%	88%	0	0	–50%	125%	0	0
O.3	Distribution Matrix	20%	12%	32%	–17%	61%	0	0	–46%	90%	0	0
O.4	Documentation/Deliverables	29%	17%	40%	–18%	75%	0	0	–53%	110%	0	0
P	PROJECT CONTROLS											
P.1	Project Quality Assurance and Control	40%	23%	48%	–16%	87%	0	0	–55%	126%	0	0
P.2	Project Cost Control	40%	24%	60%	–30%	114%	0	0	–83%	168%	0	0
P.3	Project Schedule Control	43%	28%	60%	–19%	108%	0	0	–67%	155%	0	0
P.4	Risk Management	40%	27%	46%	–3%	76%	0	1	–33%	106%	0	0
P.5	Safety, Health, Hygiene and security Management	40%	18%	50%	–29%	98%	0	2	–77%	145%	0	0
P.6	Environmental Management	33%	18%	46%	–24%	89%	0	0	–66%	131%	0	0
P.7	Project Change Control	43%	27%	67%	–33%	127%	0	0	–93%	187%	0	0
P.8	Project Audits	25%	14%	34%	–17%	65%	0	1	–47%	95%	0	0
P.9	Decision register	33%	15%	48%	–33%	96%	0	0	–82%	145%	0	0

Annexure I (Continued)– Identification of outliers and extremes

Q	**PROJECT IMPLEMENTATION PLAN**											
Q.1	Engineering / Construction Plan & Approach	43%	28%	50%	–4%	83%	0	1	–37%	115%	0	0
Q.2	Project Organization	40%	25%	54%	–18%	96%	0	0	–61%	139%	0	0
Q.3	Responsibility matrix RACI	33%	23%	40%	–4%	66%	0	1	–30%	93%	0	0
Q.4	Document Management Plan	23%	14%	32%	–12%	58%	0	1	–38%	84%	0	0
Q.5	Communication management plan	25%	17%	38%	–15%	69%	0	2	–46%	100%	0	0
Q.6	Project Delivery Method	40%	24%	48%	–13%	85%	0	0	–49%	122%	0	0
Q.7	Design / Construction Plan and Approach	40%	25%	50%	–13%	88%	0	0	–50%	125%	0	0
Q.8	Safety Procedures	30%	18%	45%	–22%	85%	0	0	–62%	125%	0	0
Q.9	Intercompany Agreements	20%	14%	40%	–24%	79%	0	1	–63%	117%	0	0
Q.10	Deliverables for Design and Construction	40%	27%	54%	–14%	94%	0	0	–54%	134%	0	0
Q.11	Labour and Skilled resources plan	33%	26%	46%	–5%	77%	0	2	–36%	108%	0	0
R	**HANDOVER & OPERATIONAL READINESS**											
R.1	Commissioning plan	40%	32%	50%	4%	78%	0	1	–23%	105%	0	0
R.2	Start–up Requirements & plans	40%	26%	50%	–10%	86%	0	0	–47%	123%	0	0
R.3	Training Requirements	30%	18%	43%	–18%	80%	0	0	–55%	116%	0	0
R.4	Substantial Completion Requirements	38%	25%	43%	–2%	70%	0	1	–29%	96%	0	0
R.5	Deliverables for Project Commissioning / Closeout	33%	23%	46%	–11%	81%	0	0	–46%	116%	0	0
R.6	Long term supply chain contracts	30%	18%	46%	–23%	87%	0	0	–64%	128%	0	0
R.7	Resourcing & staffing for operation	30%	23%	46%	–13%	82%	0	0	–49%	118%	0	0
R.8	Maintenance schedules	25%	18%	31%	–1%	50%	0	2	–20%	69%	0	2
R.9	Critical spares	25%	17%	40%	–19%	75%	0	1	–54%	111%	0	0
R.10	Start–up consumables	25%	20%	37%	–5%	62%	0	1	–30%	87%	0	0
R.11	Operational systems and procedures to support each department	27%	17%	44%	–23%	84%	0	0	–63%	124%	0	0
R.12	Environmental Management Plan for Operations (EMP)	43%	24%	50%	–15%	89%	0	0	–53%	128%	0	0

8.10 Annexure J – Comparison of Level 5 averages, after removal of outliers

SECTION I – BASIS OF PROJECT DECISION		Outliers removed									
		P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
A	**PROJECT STRATEGY**										
A.1	Project Justification	50%	100%	50%	2%	71%	71%	50%	67%	24%	33%
A.2	Project Charter and Mandate	25%	75%	50%	2%	29%	57%	50%	75%	24%	33%
A.3	Governance and control (internal approval process defined)	35%	50%	40%	2%	71%	14%	50%	83%	20%	50%
A.5	Project Strategy	25%	50%	60%	2%	14%	29%	50%		16%	33%
A.6	Strategic fit of project in organisation	50%	25%	50%	2%	14%	43%	50%	67%	16%	50%
A.7	Due diligence	50%	25%	50%	2%	71%	57%	50%	67%	16%	67%
A.8	Partnership, joint ventures and shareholder buy in	25%	100%	60%	10%	29%	71%	50%	92%	16%	17%
B	**COUNTRY RISK**										
B.1	Social Issues	20%	50%	70%	10%	71%	57%	60%	50%	30%	67%
B.2	Geo–political risks	20%	50%	70%	6%	43%	86%	60%	50%	12%	37%
B.3	Fiscal stability agreement	25%	50%	70%	6%	14%	57%	100%	17%	10%	27%
B.4	Social License to Operate	20%	50%	70%	20%		43%		50%	30%	33%
B.5	Violence and terrorism	20%	50%	100%	4%	6%	71%	100%	17%	12%	27%
B.6	Ability to appoint expatriates	25%	50%	70%	4%	3%	86%	60%	17%	14%	20%
B.7	Procurement of local and foreign materials, services and equipment	50%	50%	80%	6%	29%	86%	50%	50%	20%	67%
B.8	Country infrastructure (power, roads, rail, water ports)	50%	50%	70%	10%	43%	57%	100%	67%	30%	33%
B.9	Custom duties & logistic routes	25%	50%	70%	6%	14%	71%	100%	8%	20%	67%
C	**PROJECT FEASIBILITY**										
C.1	Resources secured (including land and mineral rights)	50%	100%	70%	10%	100%	86%	100%	50%	100%	33%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

C	PROJECT FEASIBILITY	25%	100%	70%	10%	29%	43%	100%	67%	100%	37%
C.3	Business Plan	50%	75%	70%	4%	71%	86%	100%	33%	40%	30%
C.4	Economic Analysis	50%	50%	70%	4%	71%	57%	60%	17%	30%	33%
C.5	Affordability / Feasibility	50%	100%	70%	6%	71%	86%	100%	50%	50%	33%
C.6	Contingencies (Capex & Opex)	100%	50%	50%	70%	100%	86%	50%	33%	40%	33%
C.7	Basis of Estimate	35%	50%	50%	10%	100%	100%	40%	33%	30%	37%
C.8	Scenario planning	10%	50%	50%	10%	43%	57%	70%	17%	20%	40%
D	RESOURCE AND RESERVE STATEMENT										
D.1	Metallurgical yield	25%	100%	70%	60%		100%	100%	50%	40%	50%
D.2	Reserve risks (including modifying factors)	25%	100%	50%	100%		86%	100%	67%	60%	53%
D.3	Grade engineering / control	25%	50%	50%	30%		43%	60%	33%	20%	47%
D.4	Prospect drilling standard / guideline	35%	75%	50%	10%		29%	60%	17%	30%	43%
D.5	Geological conditions (Geological model, structure, qualities)	25%	50%	50%	50%		57%	100%	67%	80%	53%
D.6	Hydrogeology	25%	50%	50%	20%		20%	60%	17%	30%	50%
E	LIFE OF MINE PLANNING										
E.1	Mine design criteria	35%	50%	50%	10%	43%	57%	60%	33%	50%	47%
E.2	Shaft/ramp design & men and material logistics	25%	25%	50%	2%	43%	43%	60%	33%	50%	53%
E.3	Mining methods (drilling, blasting, loading, hauling)	25%	50%	50%	10%	57%	29%	60%	33%	50%	47%
E.4	Equipment selection to fit geological conditions and mining method	25%	25%	50%	10%	57%	57%	60%	33%	40%	30%
E.5	Life–of–mine plan	35%	100%	50%	20%	100%	29%	100%	50%	30%	17%
E.6	Waste management plan	25%	25%	50%	2%		29%	60%	33%	30%	40%
E.7	Ultimate pit limits designed	25%	50%	50%	20%	43%	14%	60%	33%	30%	27%
E.8	Economic block values determination	15%	50%	50%	50%	100%	86%	100%	33%	30%	40%
E.9	Beneficiation facilities LOM plan	25%	50%	50%	24%	57%			33%	20%	33%
E.10	Materials handling LOM plan	25%	50%	50%	6%	57%	86%	100%	17%	20%	33%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

F	**OPERATING PHILOSOPHY**										
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	20%	50%	40%	10%	14%	29%	40%	50%	16%	27%
F.2	Productivity / efficiency benchmarks	25%	25%	40%	6%	3%	14%	30%	50%	12%	40%
F.3	Operating costs	35%	50%	60%	70%	43%	57%	100%	50%	20%	50%
F.4	Production risks	35%	40%	60%	70%	43%	71%	60%	50%	20%	50%
F.5	Catalogue of operating plans	25%	25%	40%	10%	3%	57%	40%	17%	10%	23%
F.6	Haul roads	20%	50%	50%	8%	14%	29%	70%	33%	14%	30%
F.7	Transportation strategy	20%	40%	50%	30%	29%	29%	40%	33%	16%	40%
F.8	Contractual considerations	20%	40%	40%	16%	29%	57%	20%	33%	12%	50%
G	**MARKET ANALYSIS AND STRATEGY**										
G.1	Market Strategy & Sales Agreements	25%	50%	50%	20%	100%	86%	100%	67%	30%	27%
G.2	Price risks	35%	38%	60%	70%	100%	71%	100%	83%	20%	43%
G.3	Demand risks & replacement products / technologies	35%	38%	60%	50%	100%	86%	100%	50%	20%	50%
G.4	Value–Analysis Process	25%	38%	50%	30%	57%	14%	70%	33%	30%	23%
G.5	Hedging	15%	25%	50%	30%	29%	20%	60%	17%	10%	27%
G.6	Competitor analysis	15%	25%	40%	16%	14%	14%	60%	50%	12%	17%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

SECTION I – BASIS OF PROJECT DECISION		Outliers removed								Without Outliers	With Outliers	
		P12	P13	P14	P15	P16	P17	P18	P19	Average	Average	Delta
A	PROJECT STRATEGY											
A.1	Project Justification	43%	33%	20%	17%	40%	100%	100%	42%	50,7%	50,7%	0,0%
A.2	Project Charter and Mandate	29%	13%	20%	33%	20%	40%	67%	83%	40,3%	40,3%	0,0%
A.3	Governance and control (internal approval process defined)	71%	13%	27%	33%	30%	40%	100%	83%	45,2%	45,2%	0,0%
A.5	Project Strategy	29%	47%	13%	50%	30%	60%	53%	42%	35,5%	39,0%	–3,6%
A.6	Strategic fit of project in organisation	14%	20%	13%	25%	60%	60%	33%	58%	36,2%	36,2%	0,0%
A.7	Due diligence	57%	27%	13%	17%	40%	100%	33%	67%	44,9%	44,9%	0,0%
A.8	Partnership, joint ventures and shareholder buy in	29%	27%	13%	50%	20%	40%	33%	100%	43,4%	43,4%	0,0%
B	COUNTRY RISK											
B.1	Social Issues	86%	33%	33%	67%	20%	10%	100%	100%	51,9%	51,9%	0,0%
B.2	Geo–political risks	86%	13%	33%	50%	20%	10%	53%	75%	43,0%	43,0%	0,0%
B.3	Fiscal stability agreement	23%	13%	33%	33%	16%	10%	53%	67%	34,7%	34,7%	0,0%
B.4	Social License to Operate	29%	13%	33%	33%	30%	10%	33%	42%	33,7%	41,1%	–7,4%
B.5	Violence and terrorism	86%	7%	33%	83%	10%	10%	33%	42%	39,5%	39,5%	0,0%
B.6	Ability to appoint expatriates	100%	20%	13%	50%	10%	10%	40%	92%	38,0%	38,0%	0,0%
B.7	Procurement of local and foreign materials, services and equipment	71%	13%	13%	17%	30%	10%	33%	58%	40,7%	40,7%	0,0%
B.8	Country infrastructure (power, roads, rail, water ports)	57%	13%	13%	17%	20%	10%	53%	92%	43,6%	43,6%	0,0%
B.9	Custom duties & logistic routes	71%	20%	20%	33%	20%	10%	47%	58%	39,5%	39,5%	0,0%
C	PROJECT FEASIBILITY											
C.1	Resources secured (including land and mineral rights)	57%	27%	33%	17%	40%	100%	33%	92%	61,0%	61,0%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

C	**PROJECT FEASIBILITY**											
C.2	Financing secured (Internal, external, equity, debt)	14%	33%	33%	42%	30%	100%	27%	58%	51,0%	51,0%	0,0%
C.3	Business Plan	29%	27%	27%	33%	30%	10%	33%	42%	43,9%	43,9%	0,0%
C.4	Economic Analysis	43%	20%	33%	50%	30%	60%	33%	58%	42,8%	42,8%	0,0%
C.5	Affordability / Feasibility	3%	20%	33%	25%	30%	80%	33%	50%	49,5%	49,5%	0,0%
C.6	Contingencies (Capex & Opex)	57%	100%	100%	33%	60%	60%	100%	83%	67,0%	67,0%	0,0%
C.7	Basis of Estimate	29%	13%	33%	42%	50%	100%	33%	75%	47,8%	47,8%	0,0%
C.8	Scenario planning	43%	40%	13%	17%	40%	50%	27%	42%	35,4%	35,4%	0,0%
D	**RESOURCE AND RESERVE STATEMENT**											
D.1	Metallurgical yield	14%	13%	33%	8%	100%	100%	100%	75%	61,1%	61,1%	0,0%
D.2	Reserve risks (including modifying factors)	14%	13%	67%	17%	100%	100%	100%	42%	64,3%	64,3%	0,0%
D.3	Grade engineering / control	14%	13%	67%	8%	100%	100%	67%	58%	46,2%	46,2%	0,0%
D.4	Prospect drilling standard / guideline	43%	13%	13%	25%	80%	60%	67%	83%	43,1%	43,1%	0,0%
D.5	Geological conditions (Geological model, structure, qualities)	43%	13%	67%	33%	80%	100%	33%	92%	58,4%	58,4%	0,0%
D.6	Hydrogeology	43%	13%	33%	33%	50%	50%	53%	67%	39,1%	39,1%	0,0%
E	**LIFE OF MINE PLANNING**											
E.1	Mine design criteria	29%	13%	27%	17%	50%	100%	67%	75%	45,1%	45,1%	0,0%
E.2	Shaft/ramp design & men and material logistics	71%	13%	27%	25%	30%	100%	33%	83%	42,6%	42,6%	0,0%
E.3	Mining methods (drilling, blasting, loading, hauling)	14%	13%	27%	33%	60%		33%	42%	37,3%	40,7%	–3,5%
E.4	Equipment selection to fit geological conditions and mining method	14%	13%	27%	8%	60%	100%	33%	58%	39,0%	39,0%	0,0%
E.5	Life–of–mine plan	14%	13%	13%	25%	50%	50%	27%	58%	43,4%	43,4%	0,0%
E.6	Waste management plan	57%	13%	13%	17%	50%	10%	27%	33%	30,3%	34,1%	–3,9%
E.7	Ultimate pit limits designed	14%	13%	13%	8%	50%		67%	42%	32,9%	36,7%	–3,7%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

E	**LIFE OF MINE PLANNING**											
E.8	Economic block values determination	14%	13%	33%	17%	50%	60%	67%	58%	48,1%	48,1%	0,0%
E.9	Beneficiation facilities LOM plan	43%	13%	33%	25%	50%	50%	53%	33%	37,1%	43,3%	– 6,2%
E.10	Materials handling LOM plan	57%	13%	13%	33%	40%	50%	33%	67%	41,7%	41,7%	0,0%
F	**OPERATING PHILOSOPHY**											
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	14%	13%	13%	17%	30%	80%	33%	75%	31,7%	31,7%	0,0%
F.2	Productivity / efficiency benchmarks	29%	27%	13%	25%	50%	10%	67%	58%	29,1%	29,1%	0,0%
F.3	Operating costs	57%	20%	67%	33%	50%	100%	67%	83%	56,2%	56,2%	0,0%
F.4	Production risks	57%	13%	33%	25%	40%	100%	67%	50%	49,2%	49,2%	0,0%
F.5	Catalogue of operating plans	43%	13%	13%	25%	30%	10%	80%	58%	29,0%	29,0%	0,0%
F.6	Haul roads	71%	13%	13%	17%	40%	50%	53%	67%	35,7%	35,7%	0,0%
F.7	Transportation strategy	57%	13%	13%	25%	40%	50%	47%	33%	33,6%	33,6%	0,0%
F.8	Contractual considerations	43%	27%	13%	33%	40%	50%	27%	42%	32,9%	32,9%	0,0%
G	**MARKET ANALYSIS AND STRATEGY**											
G.1	Market Strategy & Sales Agreements	14%	13%	33%	8%	50%	70%	67%	25%	46,4%	46,4%	0,0%
G.2	Price risks	14%	13%	100%	17%	50%	70%	53%	67%	55,8%	55,8%	0,0%
G.3	Demand risks & replacement products / technologies	14%	13%	67%	8%	30%	100%	67%	25%	50,7%	50,7%	0,0%
G.4	Value–Analysis Process	14%	13%	20%	25%	30%	70%	40%	33%	34,3%	34,3%	0,0%
G.5	Hedging	14%	13%	13%	3%	20%	10%	53%	50%	25,5%	25,5%	0,0%
G.6	Competitor analysis	3%	13%	20%	25%	30%	10%	0%	58%	23,5%	23,5%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

SECTION II – PROJECT DETAILS		Outliers removed									
H	PROJECT CONSIDERATIONS	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
H.1	Expected Project Life Cycle	25%	25%	70%	10%	71%	86%	50%	33%	16%	20%
H.2	Assumption register	10%	25%	30%	30%	14%	29%	50%	17%	10%	10%
H.3	Completion risks	35%	25%	50%	30%	14%	29%	50%	33%	12%	13%
H.4	Project Design Criteria	25%	25%	70%	30%	14%	86%	70%	17%	20%	17%
H.5	Scope of Work Overview	35%	100%	70%	50%	14%	86%	100%	50%	20%	33%
H.6	Project Schedule	50%		70%	50%	71%	71%	70%	67%		
H.7	Project Cost Estimate	100%	100%	50%	70%	71%	71%	70%	67%	20%	33%
H.8	Investment Studies & Alternatives Assessments	75%	50%	50%	10%	29%	43%	50%	33%	40%	27%
H.9	Key Team Member Coordination	10%	50%	50%	8%	29%	43%	50%	67%	12%	13%
H.10	Evaluation of Compliance Requirements	25%	40%	70%	6%	43%	71%	100%	50%	40%	10%
H.11	Lead / Discipline Scope of Work	10%	75%	50%	10%	14%	71%	50%	50%	12%	10%
H.12	Housing and transport of employees	15%	50%	50%	8%	14%	43%	50%	33%	16%	10%
H.13	Risk or impact on other projects / divisions	5%	25%	50%	10%	14%	29%	50%	33%	12%	17%
I	PROJECT SCOPE										
I.1	Project Objectives Statement	15%	50%	60%	6%	29%	100%	50%	50%	16%	17%
I.2	Site Characteristics Available vs. Required	15%	25%	50%	10%	29%	86%	50%	33%	10%	20%
I.3	Project Scope Definition	25%	75%	70%	40%	71%	100%	50%	50%	20%	27%
I.4	WBS and WBS Dictionary	25%	50%	50%	20%	71%	100%	50%	33%	20%	33%
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS										
J.1	Unique mine closure plan	25%	50%	50%	6%	14%	29%	40%	33%	10%	50%
J.2	Land use plan post operations	15%	40%	40%	6%	14%	14%	40%	17%	10%	50%
J.3	Social expectations register	15%	40%	60%	10%	14%	23%	40%	33%	10%	67%
J.4	Relocation Action Plan	25%	40%	80%	10%	100%	86%	40%	50%	20%	100%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS										
J.5	Environmental expectations register	25%	25%	50%	16%	43%	57%	40%	33%	20%	43%
J.6	Political expectations register	15%	25%	50%	16%	14%	23%	40%	67%	12%	50%
J.7	Legal compliance register	35%	50%	50%	8%		71%	60%	50%	16%	40%
J.8	HSE risk register	25%	25%	40%	6%	14%	51%	60%	33%	20%	27%
J.9	Community risk register	25%	25%	50%	16%	29%	43%	60%	67%	12%	67%
J.10	Business risk register	25%	25%	50%	16%	14%	57%	60%	33%	14%	23%
J.11	Developmental opportunity register	15%	25%	50%	6%	14%	29%	40%	17%	6%	47%
J.12	Sustainability operating plan	15%	50%	50%	6%	14%	29%	50%	33%	12%	27%
J.13	Stakeholder engagement plan	15%	50%	50%	10%	14%	29%	50%	33%	14%	53%
J.14	Mine closure financial provision plan	25%	50%	50%	30%	14%	29%	60%	17%	8%	50%
J.15	Closure plan review and updates scheduled during Life of Mine plan	15%	50%	40%	20%	14%	29%	60%	17%	8%	30%
J.16	Social investment plan	10%	50%	60%	6%	14%	23%	40%	33%	12%	47%
J.17	Economic diversification plan	10%	50%	50%	4%	14%	14%	40%	33%	8%	33%
J.18	Existing Environmental Conditions	25%	50%	50%	14%	14%	14%	40%	17%	10%	27%
J.19	Environmental Process determined	25%	50%	50%	16%	14%	23%	40%	33%	12%	33%
J.20	Environmental management plan	25%	50%	50%	24%	14%	14%	40%	33%	12%	40%

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Annexure J (Continued)– Comparison of Level 5 averages, after removal of outliers

SECTION II – PROJECT DETAILS		Outliers removed								Without Outliers	With Outliers	
H	**PROJECT CONSIDERATIONS**	P12	P13	P14	P15	P16	P17	P18	P19	Average	Average	Delta
H.1	Expected Project Life Cycle	57%	47%	13%	33%	60%	10%	33%	50%	39,5%	39,5%	0,0%
H.2	Assumption register	43%	33%	13%	25%	20%	70%	67%	58%	30,8%	30,8%	0,0%
H.3	Completion risks	57%	40%	13%	42%	30%	70%	33%	75%	36,2%	36,2%	0,0%
H.4	Project Design Criteria	71%	27%	13%	50%	50%	70%	67%	92%	45,2%	45,2%	0,0%
H.5	Scope of Work Overview	86%	33%	67%	50%	60%	70%	100%	83%	61,5%	61,5%	0,0%
H.6	Project Schedule	86%	67%	67%	75%	60%	70%		67%	67,2%	66,3%	0,9%
H.7	Project Cost Estimate	100%	53%	100%	83%	60%	70%	100%	58%	71,0%	71,0%	0,0%
H.8	Investment Studies & Alternatives Assessments	29%	27%	27%	25%	50%	70%	53%	33%	40,0%	40,0%	0,0%
H.9	Key Team Member Coordination	57%	13%	13%	17%	30%	70%	33%	42%	33,7%	33,7%	0,0%
H.10	Evaluation of Compliance Requirements	86%	13%	13%	33%	50%	70%	33%	33%	43,8%	43,8%	0,0%
H.11	Lead / Discipline Scope of Work	71%	20%	33%	50%	50%	70%	67%	50%	42,5%	42,5%	0,0%
H.12	Housing and transport of employees	29%	13%	20%	8%	20%	70%	33%	58%	30,1%	30,1%	0,0%
H.13	Risk or impact on other projects / divisions	29%	13%	13%	8%	20%	70%	53%	83%	29,7%	29,7%	0,0%
I	**PROJECT SCOPE**											
I.1	Project Objectives Statement	14%	13%	20%	17%	50%	100%	67%	25%	38,8%	38,8%	0,0%
I.2	Site Characteristics Available vs. Required	20%	13%	13%	42%	40%	70%	67%	42%	35,2%	35,2%	0,0%
I.3	Project Scope Definition	86%	27%	67%	50%	50%	80%	100%	58%	58,1%	58,1%	0,0%
I.4	WBS and WBS Dictionary	86%	27%	33%	67%	50%	70%	100%	50%	52,0%	52,0%	0,0%
J	**SOCIAL & ENVIRONMENTAL REQUIREMENTS**											
J.1	Unique mine closure plan	29%	13%	33%	50%	16%	40%	33%	58%	32,2%	32,2%	0,0%
J.2	Land use plan post operations	14%	13%	13%		16%	40%	33%	50%	25,1%	28,3%	– 3,2%
J.3	Social expectations register	43%	13%	13%	33%	20%	40%	33%	58%	31,5%	31,5%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS											
J.4	Relocation Action Plan	86%	13%	33%	33%	20%	40%	53%	42%	48,4%	48,4%	0,0%
J.5	Environmental expectations register	43%	13%	20%	25%	30%	40%	33%	25%	32,3%	32,3%	0,0%
J.6	Political expectations register	57%	13%	13%	33%	20%	40%	33%	33%	30,9%	30,9%	0,0%
J.7	Legal compliance register	43%	13%	33%	33%	20%	40%	53%	67%	40,2%	43,5%	–3,3%
J.8	HSE risk register	29%	13%	33%	33%	30%	40%	53%	33%	31,5%	31,5%	0,0%
J.9	Community risk register	43%	13%	33%	42%	20%	40%	53%	67%	39,1%	39,1%	0,0%
J.10	Business risk register	29%	13%	33%	25%	30%	40%	53%	42%	32,4%	32,4%	0,0%
J.11	Developmental opportunity register	57%	13%	33%	17%	30%	40%	33%	50%	29,0%	29,0%	0,0%
J.12	Sustainability operating plan	43%	13%	33%	33%	20%	40%	33%	33%	29,7%	29,7%	0,0%
J.13	Stakeholder engagement plan	29%	13%	33%	33%	20%	40%	67%	33%	32,6%	32,6%	0,0%
J.14	Mine closure financial provision plan	86%	13%	33%	8%	30%	40%	33%	75%	36,2%	36,2%	0,0%
J.15	Closure plan review and updates scheduled during Life of Mine plan	29%	13%	33%	17%	20%	40%	53%	33%	28,9%	28,9%	0,0%
J.16	Social investment plan	86%	13%	33%	33%	20%	40%	33%	50%	33,6%	33,6%	0,0%
J.17	Economic diversification plan		13%	33%	25%	20%	40%	33%	42%	27,3%	30,5%	–3,2%
J.18	Existing Environmental Conditions	43%	13%	33%	33%	30%	40%	33%	50%	29,8%	29,8%	0,0%
J.19	Environmental Process determined	29%	13%	33%	25%	30%	40%	33%	50%	30,6%	30,6%	0,0%
J.20	Environmental management plan	71%	13%	33%		30%	40%	53%	33%	34,0%	37,6%	–3,7%

SECTION III – DESIGN FOR CONSTRUCTION		Outliers removed									
K	SITE INFORMATION	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
K.1	Site Layout	35%	25%	50%	10%	43%	29%		17%	10%	17%
K.2	Site Surveys	25%	25%	50%	10%	43%	14%		17%	10%	20%
K.3	Governing Regulatory Requirements	10%	50%	70%	10%	71%	57%	60%	33%	10%	20%
K.4	Utility Sources with Supply Conditions	25%	25%	60%	10%	57%	71%	50%	17%	10%	23%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

K.5	Fire Protection, emergency procedure & Safety Considerations	25%	50%	50%	10%	14%	29%	40%	17%	8%	17%
K.6	Special Water and Waste Treatment Requirements	30%	25%	50%	10%	14%	29%	50%	33%	8%	17%
K.7	Property Descriptions	10%	25%	40%	10%	6%	23%	40%	17%	6%	10%
K.8	Right–of–Way Mapping & Site Issues	20%	25%	50%	12%	6%	23%	60%	17%	10%	13%
K.9	Land Rights	35%	50%	70%	18%	57%	43%	100%	50%	12%	27%
L	PROJECT DESIGN PARAMETERS										
L.1	Design Criteria	35%	50%	70%	6%	9%	29%	60%	17%	16%	33%
L.2	Civil/Site Design	50%	50%	50%	16%	9%	43%	60%	33%	12%	27%
L.3	Geotechnical investigation for structures	50%	35%	50%	10%	71%	43%	60%	33%	20%	43%
L.4	Architectural Design	25%	35%	40%	6%	9%	29%	60%	17%	12%	13%
L.5	Structural Design	30%	50%	60%	12%	9%	57%	60%	33%	12%	13%
L.6	Mechanical Design	30%	50%	60%	16%	9%	57%	60%	33%	12%	13%
L.7	Electrical Design	40%	50%	60%	10%	9%	43%	60%	33%	12%	13%
L.8	Constructability Analysis	50%	30%	60%	20%	9%	71%	60%	33%	12%	40%
L.9	Process Design	75%	50%	50%	30%	71%	86%	60%	50%	20%	47%
L.10	Specifications	35%	50%	50%	10%	9%	23%	60%	33%	12%	17%
L.11	Specialty Items List	15%	25%	50%	4%	9%	29%	60%	17%	12%	13%
L.12	Instrument Index	50%	50%	50%	6%	9%	23%	60%	8%	10%	27%
L.13	Control Philosophy & systems	40%	50%	50%	10%	9%	23%	60%	50%	10%	33%
L.14	Logic Diagrams	40%	50%	50%	4%	9%	23%	60%	17%	10%	27%
L.15	IM (information management)	25%	50%	50%	6%	9%	43%	60%	17%	10%	33%
L.16	Control of Access	25%	50%	50%	2%	9%	29%	60%	17%	8%	17%
L.17	Safety & Hazards	50%	50%	50%	4%	9%	29%	60%	33%	12%	33%
L.18	Operations/Maintenance	25%	50%	50%	12%	9%	23%	60%	33%	12%	23%
L.19	Ventilation Engineering	25%	40%	50%	6%	9%	29%	60%	17%	40%	27%
L.20	Rock Engineering	50%	40%	50%	16%	9%	29%	60%	8%	40%	40%
L.21	Water balances	35%	40%	50%	12%	43%	29%	60%	33%	12%	33%

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Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

L.22	Energy efficiency / carbon footprint	25%	40%	50%	4%	43%	14%	60%	17%	10%	17%
L.23	Tailings handling and storage	50%	40%	50%	18%	43%	29%	60%	33%	30%	20%
L.24	Stormwater handling / surface hydrology	50%	40%	50%	12%	43%	14%	60%	17%	12%	17%
L.25	Internal technical audits	15%	40%	40%	4%	9%	9%	60%	50%	8%	20%
L.26	External technical audits	15%	40%	40%	4%	9%	9%	60%	17%	8%	20%
M	**VALUE IMPROVING PRACTICES**										
M.1	Process Simplification	25%	25%	50%	6%	9%	57%	40%	17%	4%	27%
M.2	Design & Material Alternatives Considered/Rejected	20%	25%	40%	6%	9%	29%	30%	33%	4%	27%
M.3	Technology trends	25%	38%	40%	6%	9%	23%	30%	33%	4%	23%
M.4	Design to capacity	40%	50%	50%	8%	9%	29%	40%	33%	4%	27%
M.5	Classes of facility quality	15%	25%	50%	4%	9%	29%	30%	17%	8%	23%
M.6	Energy optimisation	15%	25%	40%	4%	9%	23%	30%	33%	4%	30%
M.7	Waste minimisation	20%	38%	40%	10%	9%	29%	50%	33%	4%	30%
M.8	3D / 4D design	40%	50%	50%	6%	9%	57%	20%	17%	4%	30%
M.9	Cleaner Production	15%	25%	50%	4%	9%	29%	30%	33%	4%	27%
M.10	Innovation and knowledge management planning	20%	38%	40%	2%	9%	29%	20%	17%	4%	33%
M.11	Six Sigma	20%	25%	50%	2%	9%	29%	10%	8%	4%	37%
M.12	Lean Manufacturing	25%	25%	40%	2%	9%	23%	10%	8%	4%	27%

Annexure J (Continued)– Comparison of Level 5 averages, after removal of outliers

SECTION III – DESIGN FOR CONSTRUCTION		Outliers removed								Without Outliers	With Outliers	
K	**SITE INFORMATION**	**P12**	**P13**	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**	**Average**	**Average**	**Delta**
K.1	Site Layout	29%	20%	33%	33%	50%	80%	53%	42%	33,8%	37,5%	–3,7%
K.2	Site Surveys	43%	33%	33%	25%	40%		33%	33%	28,4%	35,3%	–6,8%
K.3	Governing Regulatory Requirements	14%	13%	33%	25%	40%	80%	53%	50%	39,0%	39,0%	0,0%
K.4	Utility Sources with Supply Conditions	14%	13%	33%	33%	40%	100%	33%	58%	37,5%	37,5%	0,0%
K.5	Fire Protection, emergency procedure & Safety Considerations	29%	13%	33%	17%	40%	10%	33%	75%	28,3%	28,3%	0,0%
K.6	Special Water and Waste Treatment Requirements	14%	13%	33%	25%	40%		33%	58%	28,4%	32,4%	–4,0%
K.7	Property Descriptions	0%	13%	33%	17%	20%	10%	27%	33%	18,9%	18,9%	0,0%
K.8	Right–of–Way Mapping & Site Issues	6%	13%	33%	17%	40%		33%	25%	23,7%	27,9%	–4,2%
K.9	Land Rights	14%	13%	33%	25%	40%	100%	67%	42%	44,2%	44,2%	0,0%
L	**PROJECT DESIGN PARAMETERS**											
L.1	Design Criteria	43%	33%	33%	25%	50%	70%	53%	33%	37,0%	37,0%	0,0%
L.2	Civil/Site Design	29%	33%	33%	33%	50%	70%	33%	42%	37,4%	37,4%	0,0%
L.3	Geotechnical investigation for structures	14%	33%	33%	50%	50%	70%	33%	50%	41,7%	41,7%	0,0%
L.4	Architectural Design	14%	33%	13%	33%	50%	70%	27%	58%	30,2%	30,2%	0,0%
L.5	Structural Design	29%	33%	33%	50%	50%	70%	33%	42%	37,6%	37,6%	0,0%
L.6	Mechanical Design	29%	33%	33%	25%	50%	70%	33%	58%	37,3%	37,3%	0,0%
L.7	Electrical Design	29%	33%	33%	67%	50%	70%	33%	75%	40,0%	40,0%	0,0%
L.8	Constructability Analysis	43%	33%	33%	50%	40%	70%	27%	50%	40,6%	40,6%	0,0%
L.9	Process Design	57%	33%	33%	33%	40%	70%	67%	58%	51,7%	51,7%	0,0%
L.10	Specifications	29%	33%	33%	50%	50%	70%	33%	67%	36,9%	36,9%	0,0%
L.11	Specialty Items List	29%	33%	33%	33%	50%	70%	20%	92%	33,0%	33,0%	0,0%
L.12	Instrument Index	14%	33%	33%	33%	30%	70%	20%	67%	33,0%	33,0%	0,0%
L.13	Control Philosophy & systems	29%	33%	33%	50%	30%	70%	27%		35,7%	38,8%	–3,1%
L.14	Logic Diagrams	14%	33%	33%	50%	30%	70%	20%	67%	33,7%	33,7%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

L.15	IM (information management)	3%	33%	33%	42%	30%	70%	20%	42%	32,0%	32,0%	0,0%
L.16	Control of Access	14%	33%	33%	17%	20%	70%	13%	50%	28,7%	28,7%	0,0%
L.17	Safety & Hazards	14%	33%	33%	50%	30%	70%	20%	50%	35,0%	35,0%	0,0%
L.18	Operations/Maintenance	14%	33%	33%	67%	40%	70%	53%	75%	37,9%	37,9%	0,0%
L.19	Ventilation Engineering	29%	33%	33%	33%	30%	70%	53%	75%	36,6%	36,6%	0,0%
L.20	Rock Engineering	29%	33%	33%	67%	40%	70%	40%	42%	38,6%	38,6%	0,0%
L.21	Water balances	14%	33%	33%	50%	40%	70%	40%	58%	38,1%	38,1%	0,0%
L.22	Energy efficiency / carbon footprint	3%	33%	13%	67%	20%	70%	33%	50%	31,6%	31,6%	0,0%
L.23	Tailings handling and storage	43%	33%	53%	50%	20%	70%	33%		39,7%	42,2%	–2,4%
L.24	Stormwater handling / surface hydrology	29%	33%	33%	42%	20%	70%	27%	58%	34,8%	34,8%	0,0%
L.25	Internal technical audits	3%	33%	33%	25%	20%	70%	13%	25%	26,5%	26,5%	0,0%
L.26	External technical audits	3%	33%	13%	33%	30%	70%	13%	58%	26,4%	26,4%	0,0%
M	**VALUE IMPROVING PRACTICES**											
M.1	Process Simplification	14%	33%	13%	67%	50%	0%	27%	50%	28,5%	28,5%	0,0%
M.2	Design & Material Alternatives Considered/Rejected	14%	27%	13%	50%	50%	50%	27%	42%	27,5%	27,5%	0,0%
M.3	Technology trends	14%	20%	13%	50%	40%	50%	20%	67%	28,0%	28,0%	0,0%
M.4	Design to capacity	14%	13%	13%	25%	30%	50%	27%	33%	27,5%	27,5%	0,0%
M.5	Classes of facility quality	29%	13%	13%	33%	40%	0%	13%	25%	20,9%	20,9%	0,0%
M.6	Energy optimisation	43%	20%	13%	33%	40%	0%	13%	42%	23,2%	23,2%	0,0%
M.7	Waste minimisation	14%	13%	13%	33%	40%	0%	27%	58%	25,6%	25,6%	0,0%
M.8	3D / 4D design	29%	40%	13%	50%	30%	0%	20%	42%	28,1%	28,1%	0,0%
M.9	Cleaner Production	29%	27%	13%	17%	30%	0%	13%		20,8%	23,4%	–2,5%
M.10	Innovation and knowledge management planning	14%	33%	13%	50%	30%	0%	27%	33%	22,9%	22,9%	0,0%
M.11	Six Sigma	29%	33%	13%	33%	30%	0%	27%	42%	22,2%	22,2%	0,0%
M.12	Lean Manufacturing	14%	33%	13%	50%	30%	0%	20%	42%	20,8%	20,8%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

SECTION IV – IMPLEMENTATION APPROACH		Outliers removed									
N	PROCUREMENT STRATEGY	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
N.1	Identify Long Lead/Critical Equipment and Materials	35%	38%		16%	43%	14%	20%	50%	10%	33%
N.2	Procurement Procedures and Plans	25%			12%	29%	14%	30%	33%	10%	27%
N.3	Procurement Responsibility Matrix	25%	50%		4%	9%	11%	20%	17%	6%	23%
N.4	Draft contracts & proforma bidders pack	35%	50%	50%	8%	9%	20%	30%	33%	6%	23%
N.5	Contracting strategy	35%	38%	60%	16%	14%	20%	60%	33%	10%	27%
N.6	Procurement operation plan (POP)	35%	50%	50%	8%	29%	23%	40%	33%	10%	27%
O	DELIVERABLES										
O.1	CADD/Model Requirements	15%	38%	40%	4%	9%	14%	30%	17%	8%	20%
O.2	Deliverables Defined	40%	50%	60%	2%	9%	29%	40%	33%	12%	23%
O.3	Distribution Matrix	10%	38%	40%	0%	9%	23%	30%	17%	8%	20%
O.4	Documentation/Deliverables	40%	38%	50%	2%	29%	14%	30%	17%	8%	17%
P	PROJECT CONTROLS										
P.1	Project Quality Assurance and Control	25%	50%	50%	4%	57%	43%	40%	33%	10%	17%
P.2	Project Cost Control	25%	50%	50%	6%	100%	29%	40%	83%	8%	23%
P.3	Project Schedule Control	30%	50%	50%	10%	100%	43%	40%	83%	8%	23%
P.4	Risk Management	40%	75%	50%	10%	43%	29%	40%	33%	8%	27%
P.5	Safety, Health, Hygiene and security Management	40%	50%	50%	10%		14%	40%		10%	17%
P.6	Environmental Management	40%	25%	50%	10%	43%	14%	40%	50%	8%	17%
P.7	Project Change Control	50%	38%	50%	12%	100%	43%	40%	50%	10%	17%
P.8	Project Audits	35%	25%	50%	4%	14%	17%	40%	8%	8%	13%
P.9	Decision register	50%	25%	50%	8%	14%	46%	40%	33%	8%	13%

Annexure J (Continued)– Comparison of Level 5 averages, after removal of outliers

Q	**PROJECT IMPLEMENTATION PLAN**										
Q.1	Engineering / Construction Plan & Approach	50%	50%	50%	20%	14%	57%	40%	50%	12%	23%
Q.2	Project Organization	50%	38%	50%	10%	14%	57%	40%	67%	16%	30%
Q.3	Responsibility matrix RACI	40%	38%	50%	4%	14%	43%	40%	33%	12%	30%
Q.4	Document Management Plan	25%	25%	50%	2%	14%	23%	40%	17%	8%	13%
Q.5	Communication management plan	35%	25%	50%	2%	14%	17%	40%	33%	8%	17%
Q.6	Project Delivery Method	40%	25%	60%	16%	14%	23%	40%	50%	12%	30%
Q.7	Design / Construction Plan and Approach	40%	50%	50%	12%	14%	86%	40%	50%	12%	30%
Q.8	Safety Procedures	40%	50%	50%	8%	14%	23%	40%	50%	12%	17%
Q.9	Intercompany Agreements	40%	25%	40%	4%	14%	14%	40%	33%	8%	13%
Q.10	Deliverables for Design and Construction	40%	38%	50%	14%	71%	57%	40%	50%	6%	23%
Q.11	Labour and Skilled resources plan	40%	25%	50%	24%	29%	29%	40%	50%	6%	33%
R	**HANDOVER & OPERATIONAL READINESS**										
R.1	Commissioning plan	50%	50%	50%	8%	71%	43%	40%	67%	8%	30%
R.2	Start–up Requirements & plans	40%	38%	50%	6%	43%	57%	40%	50%	8%	33%
R.3	Training Requirements	25%	38%	50%	4%	43%	43%	60%	17%	8%	30%
R.4	Substantial Completion Requirements	25%	38%	50%	4%	43%	43%	40%	17%	8%	30%
R.5	Deliverables for Project Commissioning / Closeout	30%	38%	50%	4%	29%	71%	40%	33%	8%	20%
R.6	Long term supply chain contracts	30%	25%	50%	4%	14%	29%	70%	50%	8%	30%
R.7	Resourcing & staffing for operation	30%	25%	50%	8%	43%	29%	70%	33%	10%	33%
R.8	Maintenance schedules	25%	25%		4%	14%	20%		17%	10%	23%
R.9	Critical spares	25%	38%	50%	6%	14%	20%	50%	17%	8%	20%
R.10	Start–up consumables	25%	25%	50%	2%	14%	23%	40%	33%	8%	27%
R.11	Operational systems and procedures to support each department	25%	38%	50%	6%	9%	51%	60%	33%	8%	27%
R.12	Environmental Management Plan for Operations (EMP)	25%	38%	50%	6%	43%	43%	60%	50%	8%	23%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

SECTION IV – IMPLEMENTATION APPROACH		Outliers removed								Without Outliers	With Outliers	
N	**PROCUREMENT STRATEGY**	P12	P13	P14	P15	P16	P17	P18	P19	Average	Average	Delta
N.1	Identify Long Lead/Critical Equipment and Materials	43%	13%	33%	33%	40%		33%	50%	31,6%	37,5%	–5,9%
N.2	Procurement Procedures and Plans	29%	27%	33%	17%		20%	27%	25%	23,8%	28,2%	–4,4%
N.3	Procurement Responsibility Matrix	29%	20%	33%	17%	40%	20%	20%	8%	20,7%	22,9%	–2,2%
N.4	Draft contracts & proforma bidders pack	43%	47%	33%	8%	30%	20%	27%	42%	28,5%	28,5%	0,0%
N.5	Contracting strategy	43%	47%	33%	17%	40%	50%	33%	83%	36,6%	36,6%	0,0%
N.6	Procurement operation plan (POP)	29%	33%	33%	25%	40%	20%	33%		30,5%	32,5%	–2,0%
O	**DELIVERABLES**											
O.1	CADD/Model Requirements	29%	33%	20%	50%	30%	30%	27%	42%	25,2%	25,2%	0,0%
O.2	Deliverables Defined	71%	47%	20%	33%	50%	50%	27%	50%	35,9%	35,9%	0,0%
O.3	Distribution Matrix	14%	27%	20%	33%	30%	10%	20%	33%	21,2%	21,2%	0,0%
O.4	Documentation/Deliverables	6%	40%	20%	25%	40%	30%	20%	58%	26,8%	26,8%	0,0%
P	**PROJECT CONTROLS**											
P.1	Project Quality Assurance and Control	43%	47%	20%	17%	40%	70%	27%	25%	34,3%	34,3%	0,0%
P.2	Project Cost Control	86%	20%	20%	42%	40%	70%	27%	50%	42,7%	42,7%	0,0%
P.3	Project Schedule Control	71%	27%	20%	50%	40%	70%	40%	50%	44,8%	44,8%	0,0%
P.4	Risk Management	43%	40%	20%	25%	40%	70%	27%	58%	37,6%	37,6%	0,0%
P.5	Safety, Health, Hygiene and security Management	29%	33%	20%	17%	40%	50%	40%	67%	32,9%	40,3%	–7,5%
P.6	Environmental Management	29%	13%	20%	33%	40%	70%	27%	75%	33,5%	33,5%	0,0%
P.7	Project Change Control	86%	20%	20%	67%	40%	70%	33%	67%	45,1%	45,1%	0,0%
P.8	Project Audits	29%	13%	20%	17%	30%		27%	33%	22,6%	25,2%	–2,6%
P.9	Decision register	43%	13%	20%	17%	20%	70%	40%	58%	31,6%	31,6%	0,0%
Q	**PROJECT IMPLEMENTATION PLAN**											
Q.1	Engineering / Construction Plan & Approach	43%	33%	20%	42%	50%	50%	40%	67%	39,5%	39,5%	0,0%
Q.2	Project Organization	57%	60%	20%	17%	40%	50%	33%	33%	37,9%	37,9%	0,0%

Annexure J (Continued) – Comparison of Level 5 averages, after removal of outliers

Q.3	Responsibility matrix RACI	29%	33%	20%	17%	40%	40%	53%	25%	31,2%	31,2%	0,0%
Q.4	Document Management Plan	14%	27%	20%	8%	40%	30%	33%	17%	22,6%	22,6%	0,0%
Q.5	Communication management plan	14%	27%	20%	17%	40%		33%	17%	24,1%	26,6%	–2,6%
Q.6	Project Delivery Method	29%	47%	20%	33%	50%	50%	40%	42%	34,5%	34,5%	0,0%
Q.7	Design / Construction Plan and Approach	43%	47%	20%	17%	40%	50%	33%	33%	37,0%	37,0%	0,0%
Q.8	Safety Procedures	29%	33%	20%	33%	30%	10%	27%	67%	30,7%	30,7%	0,0%
Q.9	Intercompany Agreements	14%	13%	20%	17%	20%	50%	27%	42%	24,2%	24,2%	0,0%
Q.10	Deliverables for Design and Construction	71%	27%	20%	33%	50%	50%	27%	75%	41,3%	41,3%	0,0%
Q.11	Labour and Skilled resources plan	43%	27%	20%	17%	40%		27%	58%	32,7%	36,5%	–3,7%
R	**HANDOVER & OPERATIONAL READINESS**											
R.1	Commissioning plan	43%	33%	20%	25%	40%	50%	33%	33%	38,6%	38,6%	0,0%
R.2	Start–up Requirements & plans	71%	27%	20%	17%	40%	50%	27%	25%	35,6%	35,6%	0,0%
R.3	Training Requirements	29%	13%	20%	17%	40%	50%	27%	42%	30,8%	30,8%	0,0%
R.4	Substantial Completion Requirements	57%	27%	20%	25%	40%	50%	33%	42%	32,8%	32,8%	0,0%
R.5	Deliverables for Project Commissioning / Closeout	43%	27%	20%	17%	40%	50%	27%	58%	33,6%	33,6%	0,0%
R.6	Long term supply chain contracts	29%	13%	20%	17%	40%	50%	33%	42%	30,7%	30,7%	0,0%
R.7	Resourcing & staffing for operation	29%	13%	20%	8%	40%	50%	27%	50%	31,6%	31,6%	0,0%
R.8	Maintenance schedules	29%	13%	20%	25%	20%		27%	33%	20,3%	26,4%	–6,1%
R.9	Critical spares	43%	13%	20%	17%	30%	50%	33%	33%	27,1%	27,1%	0,0%
R.10	Start–up consumables	29%	13%	20%	25%	20%	50%	20%	42%	25,9%	25,9%	0,0%
R.11	Operational systems and procedures to support each department	14%	13%	20%	33%	20%	50%	27%	25%	28,3%	28,3%	0,0%
R.12	Environmental Management Plan for Operations (EMP)	43%	13%	20%	50%	50%	50%	27%	42%	35,6%	35,6%	0,0%

8.11 Annexure K – Conversion of RAT weights to fit between 70 and 1000

SECTION I – BASIS OF PROJECT DECISION		Spread between 0 and 70					Spread between 70 and 1000				
A	PROJECT STRATEGY	1	2	3	4	5	1	2	3	4	5
A.1	Project Justification	2,72	14,73	26,73	38,74	50,74	0,35	2,20	4,05	5,89	7,74
A.2	Project Charter and Mandate	2,83	12,20	21,56	30,93	40,29	0,37	1,81	3,26	4,70	6,15
A.3	Governance and control (internal approval process defined)	2,94	13,52	24,09	34,66	45,23	0,38	2,01	3,64	5,27	6,90
A.5	Project Strategy	2,94	11,07	19,20	27,33	35,46	0,38	1,64	2,90	4,15	5,41
A.6	Strategic fit of project in organisation	2,11	10,63	19,14	27,66	36,17	0,27	1,58	2,90	4,21	5,52
A.7	Due diligence	2,94	13,44	23,94	34,43	44,93	0,38	2,00	3,62	5,24	6,85
A.8	Partnership, joint ventures and shareholder buy in	3,11	13,18	23,26	33,33	43,40	0,40	1,96	3,51	5,07	6,62
B	COUNTRY RISK										
B.1	Social Issues	4,89	16,64	28,40	40,15	51,90	0,63	2,45	4,28	6,10	7,92
B.2	Geo–political risks	3,56	13,42	23,28	33,14	43,00	0,46	1,99	3,51	5,03	6,56
B.3	Fiscal stability agreement	3,06	10,97	18,88	26,79	34,70	0,40	1,62	2,84	4,07	5,29
B.4	Social License to Operate	3,72	11,23	18,73	26,23	33,74	0,48	1,65	2,81	3,98	5,15
B.5	Violence and terrorism	3,33	12,37	21,40	30,44	39,47	0,43	1,83	3,23	4,62	6,02
B.6	Ability to appoint expatriates	4,28	12,70	21,12	29,54	37,96	0,55	1,86	3,17	4,48	5,79
B.7	Procurement of local and foreign materials, services and equipment	4,06	13,23	22,40	31,57	40,74	0,53	1,95	3,37	4,79	6,22
B.8	Country infrastructure (power, roads, rail, water ports)	3,72	13,70	23,68	33,66	43,64	0,48	2,03	3,57	5,11	6,66
B.9	Custom duties & logistic routes	3,39	12,42	21,46	30,49	39,53	0,44	1,84	3,23	4,63	6,03

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

C	**PROJECT FEASIBILITY**										
C.1	Resources secured (including land and mineral rights)	2,89	17,41	31,94	46,47	60,99	0,37	2,61	4,84	7,07	9,30
C.2	Financing secured (Internal, external, equity, debt)	3,28	15,20	27,12	39,04	50,97	0,42	2,26	4,10	5,94	7,77
C.3	Business Plan	2,67	12,97	23,27	33,57	43,87	0,35	1,93	3,52	5,11	6,69
C.4	Economic Analysis	3,25	13,14	23,03	32,91	42,80	0,42	1,95	3,48	5,00	6,53
C.5	Affordability / Feasibility	3,17	14,75	26,33	37,92	49,50	0,41	2,20	3,98	5,77	7,55
C.6	Contingencies (Capex & Opex)	5,78	21,09	36,39	51,70	67,01	0,75	3,12	5,49	7,85	10,22
C.7	Basis of Estimate	4,00	14,95	25,90	36,84	47,79	0,52	2,21	3,90	5,60	7,29
C.8	Scenario planning	3,22	11,28	19,33	27,38	35,44	0,42	1,66	2,91	4,16	5,41
D	**RESOURCE AND RESERVE STATEMENT**										
D.1	Metallurgical yield	3,65	18,02	32,39	46,76	61,13	0,47	2,69	4,90	7,11	9,33
D.2	Reserve risks (including modifying factors)	4,47	19,43	34,39	49,35	64,31	0,58	2,89	5,20	7,50	9,81
D.3	Grade engineering / control	3,47	14,15	24,84	35,52	46,20	0,45	2,10	3,75	5,40	7,05
D.4	Prospect drilling standard / guideline	2,88	12,94	23,00	33,06	43,12	0,37	1,92	3,48	5,03	6,58
D.5	Geological conditions (Geological model, structure, qualities)	4,47	17,96	31,45	44,94	58,43	0,58	2,66	4,75	6,83	8,91
D.6	Hydrogeology	3,82	12,64	21,46	30,27	39,09	0,50	1,86	3,23	4,60	5,96
E	**LIFE OF MINE PLANNING**										
E.1	Mine design criteria	3,42	13,84	24,26	34,68	45,11	0,44	2,05	3,66	5,27	6,88
E.2	Shaft/ramp design & men and material logistics	3,31	13,14	22,97	32,80	42,64	0,43	1,95	3,47	4,99	6,50
E.3	Mining methods (drilling, blasting, loading, hauling)	2,67	11,31	19,96	28,61	37,25	0,35	1,68	3,01	4,35	5,68

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

E.4	Equipment selection to fit geological conditions and mining method	3,03	12,02	21,01	30,00	38,99	0,39	1,78	3,17	4,56	5,95
E.5	Life–of–mine plan	3,22	13,27	23,31	33,36	43,40	0,42	1,97	3,52	5,07	6,62
E.6	Waste management plan	3,42	10,13	16,84	23,55	30,26	0,44	1,49	2,53	3,57	4,62
E.7	Ultimate pit limits designed	3,06	10,52	17,99	25,46	32,93	0,40	1,55	2,71	3,87	5,02
E.8	Economic block values determination	3,53	14,68	25,84	36,99	48,15	0,46	2,18	3,90	5,62	7,34
E.9	Beneficiation facilities LOM plan	3,42	11,84	20,27	28,70	37,13	0,44	1,75	3,05	4,36	5,66
E.10	Materials handling LOM plan	3,53	13,08	22,63	32,17	41,72	0,46	1,93	3,41	4,89	6,36
F	**OPERATING PHILOSOPHY**										
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	2,58	9,87	17,17	24,46	31,75	0,33	1,46	2,59	3,72	4,84
F.2	Productivity / efficiency benchmarks	2,61	9,23	15,85	22,47	29,10	0,34	1,36	2,39	3,41	4,44
F.3	Operating costs	4,06	17,10	30,14	43,19	56,23	0,53	2,54	4,55	6,56	8,58
F.4	Production risks	3,72	15,08	26,44	37,80	49,15	0,48	2,24	3,99	5,74	7,50
F.5	Catalogue of operating plans	2,78	9,35	15,91	22,48	29,05	0,36	1,38	2,40	3,41	4,43
F.6	Haul roads	2,39	10,72	19,05	27,39	35,72	0,31	1,59	2,88	4,16	5,45
F.7	Transportation strategy	2,83	10,53	18,23	25,93	33,63	0,37	1,56	2,75	3,94	5,13
F.8	Contractual considerations	2,89	10,38	17,88	25,37	32,87	0,37	1,53	2,69	3,85	5,01
G	**MARKET ANALYSIS AND STRATEGY**										
G.1	Market Strategy & Sales Agreements	3,56	14,26	24,97	35,68	46,39	0,46	2,11	3,77	5,42	7,08
G.2	Price risks	4,75	17,52	30,29	43,06	55,83	0,62	2,59	4,57	6,54	8,52
G.3	Demand risks & replacement products / technologies	4,31	15,90	27,50	39,10	50,69	0,56	2,35	4,15	5,94	7,73
G.4	Value–Analysis Process	3,19	10,96	18,72	26,49	34,25	0,41	1,62	2,82	4,02	5,22
G.5	Hedging	2,72	8,42	14,13	19,83	25,53	0,35	1,24	2,12	3,01	3,89
G.6	Competitor analysis	2,53	7,77	13,01	18,25	23,49	0,33	1,14	1,96	2,77	3,58

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

SECTION II – PROJECT DETAILS		Spread between 0 and 70					Spread between 70 and 1000				
H	**PROJECT CONSIDERATIONS**										
H.1	Expected Project Life Cycle	3,83	12,74	21,65	30,55	39,46	0,50	1,88	3,26	4,64	6,02
H.2	Assumption register	3,00	9,95	16,89	23,84	30,78	0,39	1,46	2,54	3,62	4,69
H.3	Completion risks	4,00	12,06	20,11	28,17	36,22	0,52	1,77	3,02	4,27	5,52
H.4	Project Design Criteria	3,17	13,67	24,17	34,67	45,17	0,41	2,03	3,65	5,27	6,89
H.5	Scope of Work Overview	3,81	18,23	32,66	47,09	61,52	0,49	2,71	4,94	7,16	9,38
H.6	Project Schedule	4,36	20,06	35,76	51,46	67,16	0,57	2,98	5,40	7,82	10,24
H.7	Project Cost Estimate	5,28	21,71	38,13	54,56	70,99	0,68	3,22	5,75	8,29	10,82
H.8	Investment Studies & Alternatives Assessments	2,97	12,23	21,49	30,74	40,00	0,39	1,81	3,24	4,67	6,10
H.9	Key Team Member Coordination	3,11	10,76	18,41	26,07	33,72	0,40	1,59	2,77	3,96	5,14
H.10	Evaluation of Compliance Requirements	3,28	13,40	23,52	33,64	43,76	0,42	1,99	3,55	5,11	6,67
H.11	Lead / Discipline Scope of Work	3,50	13,24	22,98	32,71	42,45	0,45	1,96	3,46	4,97	6,47
H.12	Housing and transport of employees	2,75	9,58	16,41	23,25	30,08	0,36	1,41	2,47	3,53	4,59
H.13	Risk or impact on other projects / divisions	2,75	9,49	16,24	22,98	29,73	0,36	1,40	2,44	3,49	4,53
I	**PROJECT SCOPE**										
I.1	Project Objectives Statement	2,39	11,49	20,59	29,69	38,79	0,31	1,71	3,11	4,51	5,91
I.2	Site Characteristics Available vs. Required	2,78	10,89	19,01	27,12	35,24	0,36	1,61	2,87	4,12	5,37
I.3	Project Scope Definition	4,22	17,69	31,15	44,62	58,08	0,55	2,62	4,70	6,78	8,85
I.4	WBS and WBS Dictionary	3,42	15,56	27,69	39,83	51,97	0,44	2,31	4,18	6,05	7,92

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS										
J.1	Unique mine closure plan	2,61	10,02	17,42	24,82	32,23	0,34	1,48	2,63	3,77	4,91
J.2	Land use plan post operations	2,67	8,27	13,88	19,48	25,09	0,35	1,22	2,09	2,96	3,82
J.3	Social expectations register	2,78	9,95	17,13	24,31	31,48	0,36	1,47	2,58	3,69	4,80
J.4	Relocation Action Plan	4,53	15,50	26,47	37,44	48,41	0,59	2,29	3,98	5,68	7,38
J.5	Environmental expectations register	3,06	10,38	17,70	25,02	32,34	0,40	1,53	2,66	3,80	4,93
J.6	Political expectations register	2,78	9,80	16,82	23,85	30,87	0,36	1,45	2,53	3,62	4,71
J.7	Legal compliance register	3,50	12,67	21,85	31,02	40,19	0,45	1,87	3,29	4,71	6,13
J.8	HSE risk register	2,72	9,92	17,11	24,30	31,50	0,35	1,47	2,58	3,69	4,80
J.9	Community risk register	3,39	12,32	21,25	30,18	39,11	0,44	1,82	3,20	4,58	5,96
J.10	Business risk register	2,47	9,96	17,44	24,92	32,41	0,32	1,48	2,63	3,79	4,94
J.11	Developmental opportunity register	2,67	9,25	15,83	22,42	29,00	0,35	1,36	2,38	3,40	4,42
J.12	Sustainability operating plan	2,56	9,35	16,15	22,95	29,74	0,33	1,38	2,43	3,48	4,53
J.13	Stakeholder engagement plan	2,72	10,20	17,67	25,14	32,62	0,35	1,51	2,66	3,82	4,97
J.14	Mine closure financial provision plan	2,83	11,17	19,52	27,86	36,20	0,37	1,66	2,94	4,23	5,52
J.15	Closure plan review and updates scheduled during Life of Mine plan	1,78	8,57	15,36	22,16	28,95	0,23	1,28	2,32	3,37	4,41
J.16	Social investment plan	2,28	10,10	17,92	25,74	33,57	0,30	1,50	2,71	3,91	5,12
J.17	Economic diversification plan	2,11	8,41	14,70	20,99	27,29	0,27	1,25	2,22	3,19	4,16
J.18	Existing Environmental Conditions	2,00	8,96	15,92	22,88	29,84	0,26	1,33	2,40	3,48	4,55
J.19	Environmental Process determined	2,00	9,14	16,29	23,43	30,58	0,26	1,36	2,46	3,56	4,66
J.20	Environmental management plan	2,50	10,37	18,24	26,11	33,98	0,32	1,54	2,75	3,97	5,18

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

SECTION III – DESIGN FOR CONSTRUCTION		Spread between 0 and 70					Spread between 70 and 1000				
K	**SITE INFORMATION**										
K.1	Site Layout	2,94	10,66	18,38	26,10	33,82	0,38	1,58	2,77	3,96	5,16
K.2	Site Surveys	2,61	9,07	15,52	21,98	28,44	0,34	1,34	2,34	3,34	4,34
K.3	Governing Regulatory Requirements	2,50	11,61	20,73	29,84	38,96	0,32	1,73	3,13	4,54	5,94
K.4	Utility Sources with Supply Conditions	2,72	11,41	20,10	28,79	37,47	0,35	1,69	3,03	4,37	5,71
K.5	Fire Protection, emergency procedure & Safety Considerations	2,89	9,24	15,60	21,95	28,30	0,37	1,36	2,34	3,33	4,31
K.6	Special Water and Waste Treatment Requirements	2,50	8,98	15,47	21,95	28,44	0,32	1,33	2,33	3,33	4,34
K.7	Property Descriptions	2,00	6,22	10,43	14,65	18,87	0,26	0,91	1,57	2,22	2,88
K.8	Right–of–Way Mapping & Site Issues	2,22	7,59	12,96	18,33	23,70	0,29	1,12	1,95	2,78	3,61
K.9	Land Rights	2,72	13,10	23,47	33,85	44,22	0,35	1,95	3,55	5,14	6,74
L	**PROJECT DESIGN PARAMETERS**										
L.1	Design Criteria	2,47	11,09	19,72	28,34	36,96	0,32	1,65	2,98	4,31	5,63
L.2	Civil/Site Design	2,75	11,41	20,07	28,73	37,39	0,36	1,69	3,03	4,36	5,70
L.3	Geotechnical investigation for structures	3,00	12,67	22,34	32,01	41,68	0,39	1,88	3,37	4,86	6,35
L.4	Architectural Design	2,50	9,44	16,37	23,31	30,25	0,32	1,40	2,47	3,54	4,61
L.5	Structural Design	3,14	11,75	20,36	28,98	37,59	0,41	1,74	3,07	4,40	5,73
L.6	Mechanical Design	2,92	11,52	20,13	28,74	37,35	0,38	1,71	3,04	4,36	5,69
L.7	Electrical Design	3,25	12,44	21,63	30,83	40,02	0,42	1,84	3,26	4,68	6,10
L.8	Constructability Analysis	3,39	12,70	22,01	31,33	40,64	0,44	1,88	3,32	4,76	6,20
L.9	Process Design	3,78	15,76	27,75	39,73	51,72	0,49	2,34	4,19	6,04	7,88
L.10	Specifications	2,75	11,28	19,81	28,34	36,87	0,36	1,67	2,99	4,30	5,62
L.11	Specialty Items List	2,67	10,24	17,82	25,39	32,97	0,35	1,52	2,69	3,86	5,03
L.12	Instrument Index	2,92	10,43	17,94	25,45	32,97	0,38	1,54	2,70	3,86	5,03
L.13	Control Philosophy & systems	2,92	11,11	19,30	27,49	35,69	0,38	1,64	2,91	4,17	5,44

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Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

L.14	Logic Diagrams	2,64	10,40	18,16	25,93	33,69	0,34	1,54	2,74	3,94	5,14
L.15	IM (information management)	2,47	9,84	17,22	24,59	31,96	0,32	1,46	2,60	3,73	4,87
L.16	Control of Access	1,94	8,63	15,32	22,00	28,69	0,25	1,28	2,31	3,34	4,37
L.17	Safety & Hazards	2,94	10,97	18,99	27,02	35,04	0,38	1,62	2,86	4,10	5,34
L.18	Operations/Maintenance	2,72	11,53	20,33	29,14	37,95	0,35	1,71	3,07	4,43	5,78
L.19	Ventilation Engineering	3,14	11,50	19,86	28,22	36,58	0,41	1,70	2,99	4,28	5,58
L.20	Rock Engineering	3,64	12,38	21,13	29,87	38,61	0,47	1,83	3,18	4,53	5,89
L.21	Water balances	3,08	11,85	20,61	29,37	38,13	0,40	1,75	3,11	4,46	5,81
L.22	Energy efficiency / carbon footprint	3,03	10,17	17,32	24,47	31,61	0,39	1,50	2,61	3,71	4,82
L.23	Tailings handling and storage	3,53	12,58	21,64	30,69	39,74	0,46	1,86	3,26	4,66	6,06
L.24	Stormwater handling / surface hydrology	3,03	10,97	18,91	26,86	34,80	0,39	1,62	2,85	4,08	5,31
L.25	Internal technical audits	2,11	8,21	14,31	20,40	26,50	0,27	1,22	2,16	3,10	4,04
L.26	External technical audits	2,06	8,14	14,23	20,32	26,41	0,27	1,21	2,15	3,09	4,03
M	**VALUE IMPROVING PRACTICES**										
M.1	Process Simplification	2,39	8,92	15,45	21,99	28,52	0,31	1,32	2,33	3,34	4,35
M.2	Design & Material Alternatives Considered/Rejected	2,72	8,91	15,10	21,30	27,49	0,35	1,31	2,27	3,23	4,19
M.3	Technology trends	2,75	9,07	15,40	21,72	28,05	0,36	1,34	2,32	3,30	4,28
M.4	Design to capacity	2,50	8,75	15,00	21,25	27,51	0,32	1,29	2,26	3,23	4,19
M.5	Classes of facility quality	2,00	6,72	11,45	16,17	20,89	0,26	0,99	1,72	2,45	3,18
M.6	Energy optimisation	2,50	7,67	12,84	18,01	23,18	0,32	1,13	1,93	2,73	3,53
M.7	Waste minimisation	2,42	8,22	14,02	19,82	25,63	0,31	1,21	2,11	3,01	3,91
M.8	3D / 4D design	2,50	8,90	15,30	21,71	28,11	0,32	1,31	2,30	3,29	4,29
M.9	Cleaner Production	2,17	6,83	11,49	16,15	20,81	0,28	1,00	1,73	2,45	3,17
M.10	Innovation and knowledge management planning	2,47	7,57	12,67	17,77	22,87	0,32	1,11	1,90	2,69	3,49
M.11	Six Sigma	2,33	7,31	12,28	17,25	22,22	0,30	1,07	1,85	2,62	3,39
M.12	Lean Manufacturing	2,00	6,71	11,42	16,13	20,84	0,26	0,99	1,72	2,45	3,18

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

SECTION IV – IMPLEMENTATION APPROACH		Spread between 0 and 70					Spread between 70 and 1000				
N	**PROCUREMENT STRATEGY**										
N.1	Identify Long Lead/Critical Equipment and Materials	2,92	10,08	17,24	24,41	31,57	0,38	1,49	2,60	3,70	4,81
N.2	Procurement Procedures and Plans	2,67	7,95	13,23	18,50	23,78	0,35	1,17	1,99	2,81	3,63
N.3	Procurement Responsibility Matrix	2,22	6,84	11,46	16,08	20,70	0,29	1,01	1,72	2,44	3,16
N.4	Draft contracts & proforma bidders pack	2,61	9,09	15,58	22,06	28,54	0,34	1,34	2,34	3,35	4,35
N.5	Contracting strategy	2,97	11,38	19,79	28,20	36,61	0,39	1,68	2,98	4,28	5,58
N.6	Procurement operation plan (POP)	2,67	9,62	16,57	23,52	30,47	0,35	1,42	2,50	3,57	4,65
O	**DELIVERABLES**										
O.1	CADD/Model Requirements	3,14	8,66	14,19	19,71	25,24	0,41	1,27	2,13	2,99	3,85
O.2	Deliverables Defined	2,83	11,10	19,36	27,62	35,88	0,37	1,64	2,92	4,19	5,47
O.3	Distribution Matrix	2,25	6,98	11,71	16,45	21,18	0,29	1,03	1,76	2,49	3,23
O.4	Documentation/Deliverables	2,36	8,48	14,59	20,70	26,82	0,31	1,25	2,20	3,14	4,09
P	**PROJECT CONTROLS**										
P.1	Project Quality Assurance and Control	3,33	11,07	18,80	26,54	34,27	0,43	1,63	2,83	4,03	5,22
P.2	Project Cost Control	3,39	13,21	23,04	32,86	42,68	0,44	1,96	3,47	4,99	6,51
P.3	Project Schedule Control	3,50	13,81	24,13	34,44	44,76	0,45	2,05	3,64	5,23	6,82
P.4	Risk Management	3,11	11,74	20,37	29,00	37,63	0,40	1,74	3,07	4,40	5,74
P.5	Safety, Health, Hygiene and security Management	3,11	10,56	18,00	25,44	32,89	0,40	1,56	2,71	3,86	5,01
P.6	Environmental Management	2,50	10,26	18,02	25,78	33,54	0,32	1,52	2,72	3,92	5,11
P.7	Project Change Control	3,86	14,17	24,47	34,77	45,08	0,50	2,09	3,69	5,28	6,87
P.8	Project Audits	2,28	7,35	12,42	17,50	22,57	0,30	1,08	1,87	2,65	3,44
P.9	Decision register	2,56	9,82	17,08	24,34	31,60	0,33	1,45	2,57	3,70	4,82

Annexure K (Continued) – Conversion of RAT weights to fit between 70 and 1000

Q	**PROJECT IMPLEMENTATION PLAN**										
Q.1	Engineering / Construction Plan & Approach	3,39	12,42	21,45	30,48	39,52	0,44	1,84	3,23	4,63	6,02
Q.2	Project Organization	3,03	11,74	20,46	29,18	37,89	0,39	1,74	3,08	4,43	5,78
Q.3	Responsibility matrix RACI	2,58	9,73	16,87	24,02	31,16	0,33	1,44	2,54	3,65	4,75
Q.4	Document Management Plan	1,78	6,98	12,18	17,38	22,58	0,23	1,03	1,84	2,64	3,44
Q.5	Communication management plan	2,61	7,97	13,34	18,70	24,06	0,34	1,17	2,00	2,84	3,67
Q.6	Project Delivery Method	2,67	10,62	18,57	26,52	34,47	0,35	1,57	2,80	4,03	5,25
Q.7	Design / Construction Plan and Approach	3,17	11,64	20,11	28,58	37,05	0,41	1,72	3,03	4,34	5,65
Q.8	Safety Procedures	2,72	9,71	16,71	23,70	30,69	0,35	1,43	2,52	3,60	4,68
Q.9	Intercompany Agreements	1,89	7,46	13,02	18,59	24,16	0,24	1,10	1,96	2,82	3,68
Q.10	Deliverables for Design and Construction	3,31	12,79	22,28	31,76	41,25	0,43	1,89	3,36	4,82	6,29
Q.11	Labour and Skilled resources plan	3,39	10,73	18,07	25,41	32,75	0,44	1,58	2,72	3,85	4,99
R	**HANDOVER & OPERATIONAL READINESS**										
R.1	Commissioning plan	3,78	12,48	21,19	29,89	38,60	0,49	1,84	3,19	4,54	5,88
R.2	Start–up Requirements & plans	3,03	11,18	19,33	27,48	35,63	0,39	1,65	2,91	4,17	5,43
R.3	Training Requirements	2,86	9,84	16,81	23,79	30,77	0,37	1,45	2,53	3,61	4,69
R.4	Substantial Completion Requirements	2,97	10,43	17,89	25,36	32,82	0,39	1,54	2,69	3,85	5,00
R.5	Deliverables for Project Commissioning / Closeout	2,47	10,24	18,01	25,79	33,56	0,32	1,52	2,72	3,92	5,12
R.6	Long term supply chain contracts	2,67	9,69	16,71	23,73	30,75	0,35	1,43	2,52	3,60	4,69
R.7	Resourcing & staffing for operation	3,00	10,14	17,28	24,42	31,56	0,39	1,49	2,60	3,71	4,81
R.8	Maintenance schedules	2,17	6,71	11,26	15,80	20,35	0,28	0,99	1,69	2,40	3,10
R.9	Critical spares	2,53	8,66	14,79	20,92	27,05	0,33	1,28	2,23	3,18	4,12
R.10	Start–up consumables	2,56	8,38	14,21	20,04	25,87	0,33	1,23	2,14	3,04	3,94
R.11	Operational systems and procedures to support each department	2,53	8,97	15,41	21,85	28,28	0,33	1,32	2,32	3,32	4,31
R.12	Environmental Management Plan for Operations (EMP)	3,19	11,29	19,38	27,47	35,56	0,41	1,67	2,92	4,17	5,42

8.12 Annexure L – Interpolation of values for 2,3 and 4 weights

SECTION I – BASIS OF PROJECT DECISION						
A	PROJECT STRATEGY	1	2	3	4	5
A.1	Project Justification	0,35	2,20	4,05	5,89	7,74
A.2	Project Charter and Mandate	0,37	1,81	3,26	4,70	6,15
A.3	Governance and control (internal approval process defined)	0,38	2,01	3,64	5,27	6,90
A.5	Project Strategy	0,38	1,64	2,90	4,15	5,41
A.6	Strategic fit of project in organisation	0,27	1,58	2,90	4,21	5,52
A.7	Due diligence	0,38	2,00	3,62	5,24	6,85
A.8	Partnership, joint ventures and shareholder buy in	0,40	1,96	3,51	5,07	6,62
B	COUNTRY RISK					
B.1	Social Issues	0,63	2,45	4,28	6,10	7,92
B.2	Geo–political risks	0,46	1,99	3,51	5,03	6,56
B.3	Fiscal stability agreement	0,40	1,62	2,84	4,07	5,29
B.4	Social License to Operate	0,48	1,65	2,81	3,98	5,15
B.5	Violence and terrorism	0,43	1,83	3,23	4,62	6,02
B.6	Ability to appoint expatriates	0,55	1,86	3,17	4,48	5,79
B.7	Procurement of local and foreign materials, services and equipment	0,53	1,95	3,37	4,79	6,22
B.8	Country infrastructure (power, roads, rail, water ports)	0,48	2,03	3,57	5,11	6,66
B.9	Custom duties & logistic routes	0,44	1,84	3,23	4,63	6,03
C	PROJECT FEASIBILITY					
C.1	Resources secured (including land and mineral rights)	0,37	2,61	4,84	7,07	9,30
C.2	Financing secured (Internal, external, equity, debt)	0,42	2,26	4,10	5,94	7,77
C.3	Business Plan	0,35	1,93	3,52	5,11	6,69
C.4	Economic Analysis	0,42	1,95	3,48	5,00	6,53
C.5	Affordability / Feasibility	0,41	2,20	3,98	5,77	7,55

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

C	PROJECT FEASIBILITY	1	2	3	4	5
C.6	Contingencies (Capex & Opex)	0,75	3,12	5,49	7,85	10,22
C.7	Basis of Estimate	0,52	2,21	3,90	5,60	7,29
C.8	Scenario planning	0,42	1,66	2,91	4,16	5,41
D	**RESOURCE AND RESERVE STATEMENT**					
D.1	Metallurgical yield	0,47	2,69	4,90	7,11	9,33
D.2	Reserve risks (including modifying factors)	0,58	2,89	5,20	7,50	9,81
D.3	Grade engineering / control	0,45	2,10	3,75	5,40	7,05
D.4	Prospect drilling standard / guideline	0,37	1,92	3,48	5,03	6,58
D.5	Geological conditions (Geological model, structure, qualities)	0,58	2,66	4,75	6,83	8,91
D.6	Hydrogeology	0,50	1,86	3,23	4,60	5,96
E	**LIFE OF MINE PLANNING**					
E.1	Mine design criteria	0,44	2,05	3,66	5,27	6,88
E.2	Shaft/ramp design & men and material logistics	0,43	1,95	3,47	4,99	6,50
E.3	Mining methods (drilling, blasting, loading, hauling)	0,35	1,68	3,01	4,35	5,68
E.4	Equipment selection to fit geological conditions and mining method	0,39	1,78	3,17	4,56	5,95
E.5	Life–of–mine plan	0,42	1,97	3,52	5,07	6,62
E.6	Waste management plan	0,44	1,49	2,53	3,57	4,62
E.7	Ultimate pit limits designed	0,40	1,55	2,71	3,87	5,02
E.8	Economic block values determination	0,46	2,18	3,90	5,62	7,34
E.9	Beneficiation facilities LOM plan	0,44	1,75	3,05	4,36	5,66
E.10	Materials handling LOM plan	0,46	1,93	3,41	4,89	6,36
F	**OPERATING PHILOSOPHY**					
F.1	Operating Philosophy (Outsourcing vs internal vs combination)	0,33	1,46	2,59	3,72	4,84
F.2	Productivity / efficiency benchmarks	0,34	1,36	2,39	3,41	4,44
F.3	Operating costs	0,53	2,54	4,55	6,56	8,58
F.4	Production risks	0,48	2,24	3,99	5,74	7,50
F.5	Catalogue of operating plans	0,36	1,38	2,40	3,41	4,43

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

F	OPERATING PHILOSOPHY	1	2	3	4	5
F.6	Haul roads	0,31	1,59	2,88	4,16	5,45
F.7	Transportation strategy	0,37	1,56	2,75	3,94	5,13
F.8	Contractual considerations	0,37	1,53	2,69	3,85	5,01
G	MARKET ANALYSIS AND STRATEGY					
G.1	Market Strategy & Sales Agreements	0,46	2,11	3,77	5,42	7,08
G.2	Price risks	0,62	2,59	4,57	6,54	8,52
G.3	Demand risks & replacement products / technologies	0,56	2,35	4,15	5,94	7,73
G.4	Value–Analysis Process	0,41	1,62	2,82	4,02	5,22
G.5	Hedging	0,35	1,24	2,12	3,01	3,89
G.6	Competitor analysis	0,33	1,14	1,96	2,77	3,58

SECTION II – PROJECT DETAILS						
H	PROJECT CONSIDERATIONS					
H.1	Expected Project Life Cycle	0,50	1,88	3,26	4,64	6,02
H.2	Assumption register	0,39	1,47	2,54	3,62	4,70
H.3	Completion risks	0,52	1,77	3,02	4,27	5,53
H.4	Project Design Criteria	0,41	2,03	3,65	5,27	6,89
H.5	Scope of Work Overview	0,49	2,72	4,94	7,16	9,38
H.6	Project Schedule	0,57	2,99	5,41	7,82	10,24
H.7	Project Cost Estimate	0,68	3,22	5,76	8,29	10,83
H.8	Investment Studies & Alternatives Assessments	0,39	1,81	3,24	4,67	6,10
H.9	Key Team Member Coordination	0,40	1,59	2,77	3,96	5,14
H.10	Evaluation of Compliance Requirements	0,42	1,99	3,55	5,11	6,68
H.11	Lead / Discipline Scope of Work	0,45	1,96	3,46	4,97	6,48
H.12	Housing and transport of employees	0,36	1,41	2,47	3,53	4,59
H.13	Risk or impact on other projects / divisions	0,36	1,40	2,45	3,49	4,53

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

I	PROJECT SCOPE	1	2	3	4	5
I.1	Project Objectives Statement	0,31	1,71	3,11	4,52	5,92
I.2	Site Characteristics Available vs. Required	0,36	1,61	2,87	4,12	5,38
I.3	Project Scope Definition	0,55	2,63	4,70	6,78	8,86
I.4	WBS and WBS Dictionary	0,44	2,31	4,19	6,06	7,93
J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	1	2	3	4	5
J.1	Unique mine closure plan	0,34	1,48	2,63	3,77	4,92
J.2	Land use plan post operations	0,35	1,22	2,09	2,96	3,83
J.3	Social expectations register	0,36	1,47	2,58	3,69	4,80
J.4	Relocation Action Plan	0,59	2,29	3,99	5,69	7,38
J.5	Environmental expectations register	0,40	1,53	2,66	3,80	4,93
J.6	Political expectations register	0,36	1,45	2,53	3,62	4,71
J.7	Legal compliance register	0,45	1,87	3,29	4,71	6,13
J.8	HSE risk register	0,35	1,47	2,58	3,69	4,80
J.9	Community risk register	0,44	1,82	3,20	4,58	5,97
J.10	Business risk register	0,32	1,48	2,63	3,79	4,94
J.11	Developmental opportunity register	0,35	1,37	2,38	3,40	4,42
J.12	Sustainability operating plan	0,33	1,38	2,43	3,49	4,54

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

J	SOCIAL & ENVIRONMENTAL REQUIREMENTS	1	2	3	4	5
J.13	Stakeholder engagement plan	0,35	1,51	2,66	3,82	4,98
J.14	Mine closure financial provision plan	0,37	1,66	2,94	4,23	5,52
J.15	Closure plan review and updates scheduled during Life of Mine plan	0,23	1,28	2,32	3,37	4,42
J.16	Social investment plan	0,30	1,50	2,71	3,91	5,12
J.17	Economic diversification plan	0,27	1,25	2,22	3,19	4,16
J.18	Existing Environmental Conditions	0,26	1,33	2,41	3,48	4,55
J.19	Environmental Process determined	0,26	1,36	2,46	3,56	4,66
J.20	Environmental management plan	0,32	1,54	2,75	3,97	5,18

SECTION III – DESIGN FOR CONSTRUCTION						
K	SITE INFORMATION	1	2	3	4	5
K.1	Site Layout	0,38	1,58	2,77	3,97	5,16
K.2	Site Surveys	0,34	1,34	2,34	3,34	4,34
K.3	Governing Regulatory Requirements	0,32	1,73	3,13	4,54	5,94
K.4	Utility Sources with Supply Conditions	0,35	1,69	3,03	4,38	5,72
K.5	Fire Protection, emergency procedure & Safety Considerations	0,37	1,36	2,35	3,33	4,32
K.6	Special Water and Waste Treatment Requirements	0,32	1,33	2,33	3,33	4,34
K.7	Property Descriptions	0,26	0,91	1,57	2,22	2,88
K.8	Right–of–Way Mapping & Site Issues	0,29	1,12	1,95	2,78	3,62
K.9	Land Rights	0,35	1,95	3,55	5,15	6,75
L	PROJECT DESIGN PARAMETERS					
L.1	Design Criteria	0,32	1,65	2,98	4,31	5,64
L.2	Civil/Site Design	0,36	1,69	3,03	4,37	5,70
L.3	Geotechnical investigation for structures	0,39	1,88	3,37	4,87	6,36
L.4	Architectural Design	0,32	1,40	2,47	3,54	4,61
L.5	Structural Design	0,41	1,74	3,07	4,40	5,73
L.6	Mechanical Design	0,38	1,71	3,04	4,37	5,70
L.7	Electrical Design	0,42	1,84	3,26	4,68	6,10
L.8	Constructability Analysis	0,44	1,88	3,32	4,76	6,20
L.9	Process Design	0,49	2,34	4,19	6,04	7,89
L.10	Specifications	0,36	1,67	2,99	4,31	5,62
L.11	Specialty Items List	0,35	1,52	2,69	3,86	5,03
L.12	Instrument Index	0,38	1,54	2,70	3,87	5,03
L.13	Control Philosophy & systems	0,38	1,64	2,91	4,18	5,44
L.14	Logic Diagrams	0,34	1,54	2,74	3,94	5,14

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

L	PROJECT DESIGN PARAMETERS	1	2	3	4	5
L.15	IM (information management)	0,32	1,46	2,60	3,74	4,88
L.16	Control of Access	0,25	1,28	2,31	3,35	4,38
L.17	Safety & Hazards	0,38	1,62	2,86	4,10	5,35
L.18	Operations/Maintenance	0,35	1,71	3,07	4,43	5,79
L.19	Ventilation Engineering	0,41	1,70	2,99	4,29	5,58
L.20	Rock Engineering	0,47	1,83	3,18	4,54	5,89
L.21	Water balances	0,40	1,75	3,11	4,46	5,82
L.22	Energy efficiency / carbon footprint	0,39	1,50	2,61	3,71	4,82
L.23	Tailings handling and storage	0,46	1,86	3,26	4,66	6,06
L.24	Stormwater handling / surface hydrology	0,39	1,62	2,85	4,08	5,31
L.25	Internal technical audits	0,27	1,22	2,16	3,10	4,04
L.26	External technical audits	0,27	1,21	2,15	3,09	4,03
M	VALUE IMPROVING PRACTICES					
M.1	Process Simplification	0,31	1,32	2,33	3,34	4,35
M.2	Design & Material Alternatives Considered/Rejected	0,35	1,31	2,27	3,23	4,19
M.3	Technology trends	0,36	1,34	2,32	3,30	4,28
M.4	Design to capacity	0,32	1,29	2,26	3,23	4,20
M.5	Classes of facility quality	0,26	0,99	1,72	2,45	3,19
M.6	Energy optimisation	0,32	1,13	1,93	2,73	3,54
M.7	Waste minimisation	0,31	1,21	2,11	3,01	3,91
M.8	3D / 4D design	0,32	1,32	2,31	3,30	4,29
M.9	Cleaner Production	0,28	1,00	1,73	2,45	3,17
M.10	Innovation and knowledge management planning	0,32	1,11	1,90	2,70	3,49
M.11	Six Sigma	0,30	1,07	1,85	2,62	3,39
M.12	Lean Manufacturing	0,26	0,99	1,72	2,45	3,18

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

SECTION IV – IMPLEMENTATION APPROACH						
N	PROCUREMENT STRATEGY	1	2	3	4	5
N.1	Identify Long Lead/Critical Equipment and Materials	0,38	1,49	2,60	3,71	4,82
N.2	Procurement Procedures and Plans	0,35	1,17	1,99	2,81	3,63
N.3	Procurement Responsibility Matrix	0,29	1,01	1,72	2,44	3,16
N.4	Draft contracts & proforma bidders pack	0,34	1,34	2,35	3,35	4,35
N.5	Contracting strategy	0,39	1,69	2,98	4,28	5,58
N.6	Procurement operation plan (POP)	0,35	1,42	2,50	3,57	4,65

Annexure L (Continued) – Interpolation of values for 2,3 and 4 weights

O	DELIVERABLES	1	2	3	4	5
O.1	CADD/Model Requirements	0,41	1,27	2,13	2,99	3,85
O.2	Deliverables Defined	0,37	1,64	2,92	4,20	5,47
O.3	Distribution Matrix	0,29	1,03	1,76	2,50	3,23
O.4	Documentation/Deliverables	0,31	1,25	2,20	3,14	4,09
P	PROJECT CONTROLS					
P.1	Project Quality Assurance and Control	0,43	1,63	2,83	4,03	5,23
P.2	Project Cost Control	0,44	1,96	3,48	4,99	6,51
P.3	Project Schedule Control	0,45	2,05	3,64	5,23	6,83
P.4	Risk Management	0,40	1,74	3,07	4,41	5,74
P.5	Safety, Health, Hygiene and security Management	0,40	1,56	2,71	3,86	5,02
P.6	Environmental Management	0,32	1,52	2,72	3,92	5,12
P.7	Project Change Control	0,50	2,09	3,69	5,28	6,88
P.8	Project Audits	0,30	1,08	1,87	2,66	3,44
P.9	Decision register	0,33	1,45	2,58	3,70	4,82

Q	PROJECT IMPLEMENTATION PLAN	1	2	3	4	5
Q.1	Engineering / Construction Plan & Approach	0,44	1,84	3,23	4,63	6,03
Q.2	Project Organization	0,39	1,74	3,09	4,43	5,78
Q.3	Responsibility matrix RACI	0,33	1,44	2,54	3,65	4,75
Q.4	Document Management Plan	0,23	1,03	1,84	2,64	3,44
Q.5	Communication management plan	0,34	1,17	2,00	2,84	3,67
Q.6	Project Delivery Method	0,35	1,57	2,80	4,03	5,26
Q.7	Design / Construction Plan and Approach	0,41	1,72	3,03	4,34	5,65
Q.8	Safety Procedures	0,35	1,44	2,52	3,60	4,68
Q.9	Intercompany Agreements	0,24	1,10	1,97	2,83	3,69
Q.10	Deliverables for Design and Construction	0,43	1,89	3,36	4,83	6,29
Q.11	Labour and Skilled resources plan	0,44	1,58	2,72	3,86	4,99
R	HANDOVER & OPERATIONAL READINESS					
R.1	Commissioning plan	0,49	1,84	3,19	4,54	5,89
R.2	Start–up Requirements & plans	0,39	1,65	2,91	4,17	5,43
R.3	Training Requirements	0,37	1,45	2,53	3,61	4,69
R.4	Substantial Completion Requirements	0,39	1,54	2,70	3,85	5,01
R.5	Deliverables for Project Commissioning / Closeout	0,32	1,52	2,72	3,92	5,12
R.6	Long term supply chain contracts	0,35	1,43	2,52	3,60	4,69
R.7	Resourcing & staffing for operation	0,39	1,50	2,60	3,71	4,81
R.8	Maintenance schedules	0,28	0,99	1,69	2,40	3,10
R.9	Critical spares	0,33	1,28	2,23	3,18	4,13
R.10	Start–up consumables	0,33	1,24	2,14	3,04	3,95
R.11	Operational systems and procedures to support each department	0,33	1,32	2,32	3,32	4,31
R.12	Environmental Management Plan for Operations (EMP)	0,41	1,67	2,92	4,17	5,42

8.13 Annexure M – Questionnaire regarding completed projects

<u>Instructions for completion of Completed Project Information</u>

1 Consider a recent project which you were involved with and are familiar with
2 Complete the information on the sheet below, as well as on the next sheet (2. Completed Project), keeping this recently completed project in mind.

Project Background information

Greenfield

Brownfield

Schedule information

Original intended duration of design and construction (months)

Actual duration of design and construction

Cost information

Original intended cost of design and construction

Amount of contingency included in the above

Actual cost of design and construction

Currency of above values ($?)

Change information

What was the total number of change orders issued (including during detail design and construction)

What was the total monetary value of all change orders?

What was the net duration change in the completion date due to change orders (months)

Did the change increase or decrease the original project duration? (Mark one with an X)

Increase

Decrease

Investment information

Using a scale of 1 – 5 (1 being fallen far short and 5 being far exceeded all expectations) how has the actual performance of the delivered project measured up to the expected performance? (Mark with an X)

1
2
3
4
5

Operating performance

Using a scale of 1 – 5 (1 being fallen far short and 5 being far exceeded all expectations) – Since being placed in service, has the operational performance (including capacity and availability) met the expectations?

1
2
3
4
5

Customer satisfaction

Using a scale of 1 – 5 (1 being very unsuccessful and 5 being very successful) – Reflecting on the overall project, rate the success of the project

1
2
3
4
5