VALUE DRIVEN RESOURCE ALLOCATION AND FOCUS IN THE EARLY STAGES OF PROJECT DEVELOPMENT

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ABSTRACT

The mining industry is facing a serious skills resource shortage, growing commodity demand and cyclical prices. This makes focus and allocation of resources in the early stages of project development very important. To assist with these six key elements in the project prioritization process is proposed, namely: 1) Define the project vision, objectives and business case, 2) Determine the potential show stoppers, 3) Determine the key value drivers, 4) Track changes and provide regular feedback, 5) Evaluate the alternatives and, 6) Ensure proper gate management governance at the decision point. Incorporating these elements in the project development process will assist in resource allocation and focus on the high value aspects of projects and alternatives during the early stages of the project development lifecycle.

Keywords: Resource allocation and focus, vision, show stoppers, value drivers, project prioritization, linear programming, business case modelling, management decision.

INTRODUCTION

THE PROJECT DEVELOPMENT ENVIRONMENT

Exxaro Resources was formed in late 2006 from an empowerment deal between Kumba Resources and Eyesizwe Coal. It is South Africa's largest diversified black-owned mining company with assets in coal, base metals and heavy minerals.

Mining and engineering companies globally are competing for skilled human resources to sustain and develop their business to meet the growing demand for commodities from China and India. In addition South African mining companies have committed to develop, attract and retain experienced candidates to meet their employment equity targets set by the mining charter. In addition, the base metals industry is further challenged by cyclic market conditions. This makes it important that resources should be deployed and focussed on development and implementation of the highest value initiatives that align with the business' sustaining and growth strategy.

The purpose of this paper is to present some key elements that have been incorporated into Exxaro Base Metals' project methodology to allocate and focus resources on the highest value initiatives during the early project development lifecycle.

THE PROJECT DEVELOPMENT LIFE CYCLE

Exxaro, as other mining companies, uses a central project management and engineering department to supply skilled human resources for the development of its projects. It uses the principle of managing-by-projects to develop and implement the business strategy.

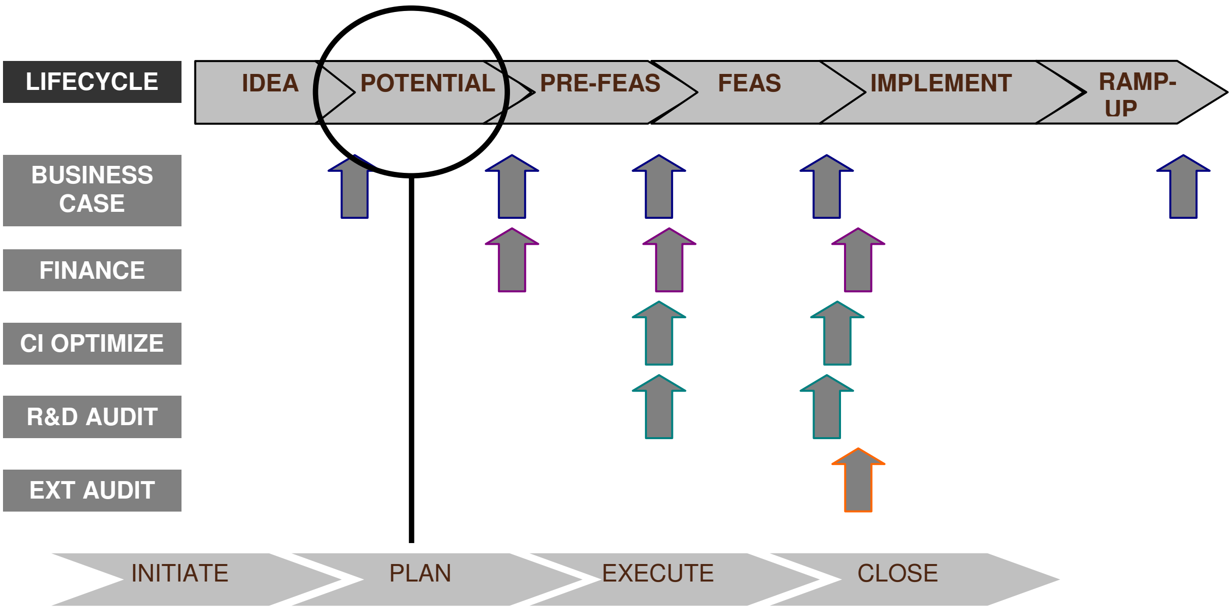

Figure 1 Exxaro Project Development Lifecycle

Exxaro's project development lifecycle, depicted in Figure 1, consist of five phases, namely: 1) Idea generation, 2) Potential, 3) Pre-Feasibility, 4) Feasibility, 5) Implementation and 6) Ramp-up. Each phase is divided into the four main project management steps, that is: i) initiate, ii) plan, iii) execute and iv) close.

The project development lifecycle is interrupted by various interventions such as business case modelling, formal project financing and approval, project optimisation, research and development and external audits. These are utilized as gate management opportunities to ensure quality deliverables are produced and to stop or allow projects to continue.

The sum total of the project phases, project sub-phases and various business interventions is what makes up Exxaro's high level project development lifecycle.

PROBLEM STATEMENT

In the normal course of the project development lifecycle, various gaps and opportunities develop; if these are neglected it could lead the misdirection of valuable resources on low impact and/or low value aspects of the project.

RESOURCE ALLOCATION AND FOCUS

In most organisations, ideas to enhance and grow current business can come from various sources; from floor level at business unit right up to executive management level. These ideas are usually captured via different forums and meetings required to operate the business from day to day. The amount of resources allocated to progress an idea through the project lifecycle will depend on availability and skill of resources in the company as well as the governance, processes and tools the company have put in place to develop ideas to projects.

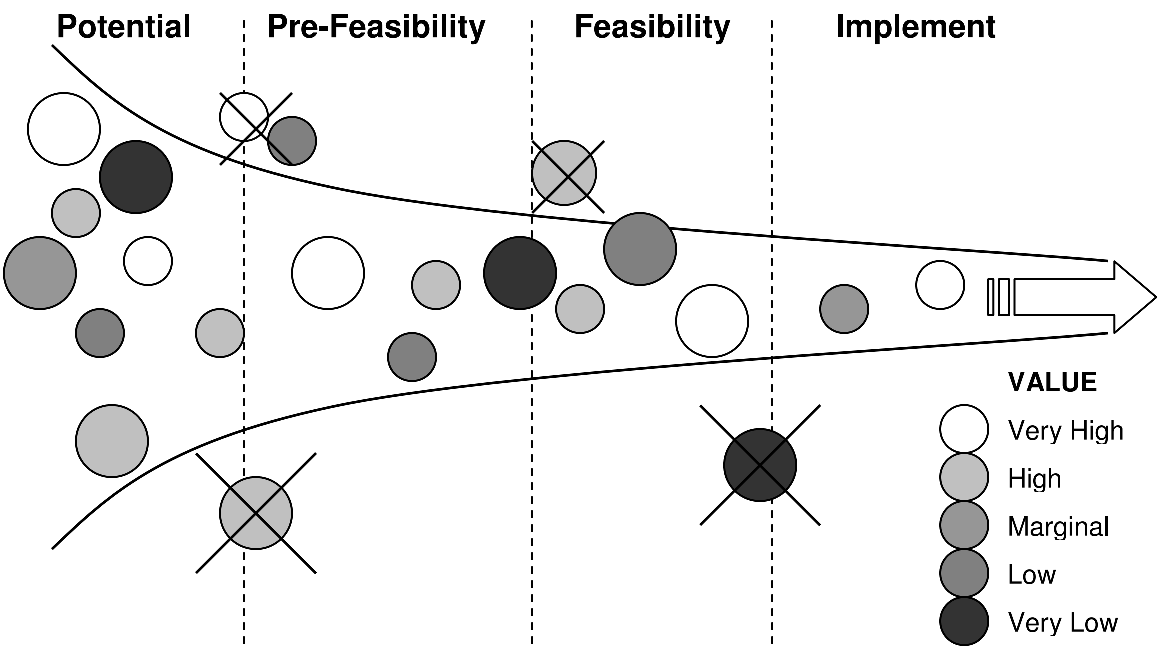

Figure 2 Schematic illustration of a Project Pipeline

In cases where one or more of these elements are lacking, valuable resources can be wasted on low value ideas or projects. Figure 2 gives a schematic example of cases where marginal value initiatives can end up in feasibility and even as far as the implementation phase. High value projects can lag behind or even be shelved due to the constraint on resources to progress projects through the pipeline. This could result in lost valuable opportunities.

It is imperative to have formalized governance, processes and tools in place to capture, evaluate and screen ideas and projects in order to rapidly and accurately prioritize and allocate resources to the highest value projects.

PROPOSED METHODOLOGY

KEY FACTORS IN THE PROJECT PRIORITIZATION PROCESS

The six key elements in the project prioritization process are:

1) Define the project vision, objectives and business case
2) Determine the potential show stoppers
3) Determine the key value drivers
4) Track changes and provide regular feedback
5) Evaluate the alternatives and
6) Ensure proper gate management governance at the decision point

A pre-feasibility study performed during 2007 for Rosh Pinah Zinc Corporation in Namibia is used as an example of the project prioritization process. Rosh Pinah Zinc Corporation is a zinc-lead mine in southern Namibia. The pre-feasibility study investigated the potential to exploit a massive low grade zinc-lead resource of some 20.4 million tonnes of ore at 2.62% Zn and 0.58% Pb content. In the preceding potential study it was proposed to pre-beneficiate a low grade ore body by means of an underground pre-beneficiation plant and blending the pre-beneficiated low grade material with higher grade material through the current operation[1]. The waste produced by the pre-beneficiation plant would be back-filled into open stopes created by mining activity with only the pre-beneficiation product being conveyed out to surface.

VISION, OBJECTIVES AND BUSINESS CASE

In an environment where project managers and project members work across commodity boundaries, the project team often does not form a clear vision of how the project aligns with the overall business strategy. Other ideas and potential projects related to the specific project are also not clearly visible to the project team resulting in “dark room” or “silo” syndrome where engineering and business interfaces are not well understood or defined. Misaligned and non-coherent generation of alternatives and solutions result could cause projects to proceed to feasibility where costly rework has to be done, usually after quite a large part of design and test work has been performed.

To understand the vision and strategic fit of a project to the business unit plan, the project team must hold a **Stakeholders Requirements Workshop** with the relevant business unit personnel as well as key executive committee members and technical experts. The meeting must crystallise the vision, high level scope, specific business drivers, impact on business unit, project work breakdown structure, key deliverables and milestones, costing structure, resource requirement, roles and responsibilities, key assumptions, risks and constraints of the project. It must include a review of the business case assumptions and list the high level alternatives to be investigated in the next phase.

The outcome of the workshop together with previous supporting documentation are then compiled into a Terms of Reference Document which forms the basis for the Steering Committee and project team and marks the starting point of the project planning phase.

The vision of the Rosh Pinah Resource Utilization project was to increase volumes through the plant, extend the life of mine and maximize utilization of the resource at Rosh Pinah Zinc Corporation.

POTENTIAL SHOW STOPPERS

Project managers have a natural tendency to drive hard for completion and usually the project scope and battery limits are defined and ring fenced, and within these boundaries time, cost and quality are managed. It could happen that as the project is developed that elements internal to the project or apparently external to the project (in the business value chain) cause the project to be delayed, stopped, or its intent fatally challenged.

As part of the project planning phase, a **Show Stopper Workshop** should be held with participation by the project team and key operational personnel. The workshop aims to identify potential show stoppers or fatal flaws in the project by considering the six elements of the Business Value Chain: 1) Resource, 2) Process, 3) Product, 4) Logistics, 5) Market and 6) Environment (Figure 3).

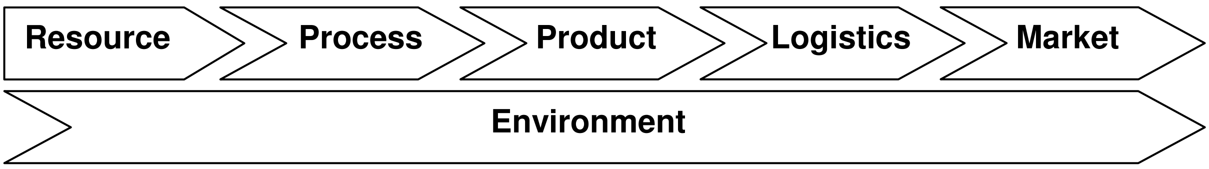

Figure 3 **Elements of the Business Value Chain**

Assumptions around these elements are stated as hypothesis to be tested. The outcome of this process is a list of potential show stoppers or fatal flaws to be investigated further by the project team.

The potential show stoppers identified in our example project were 1) the delineation of the ore body, 2) ability to pre-beneficiate the ore body and 3) placing the pre-beneficiation plant underground or above ground. Failing to resolve the three main potential show stoppers could have resulted in designing a perfect engineering solution based on possible erroneous or incomplete information.

In our example project the delineation of the ore body was of such a nature that Sub-Level Open Stoping, depicted in Figure 4, could be used as a mining method to mine the ore body.

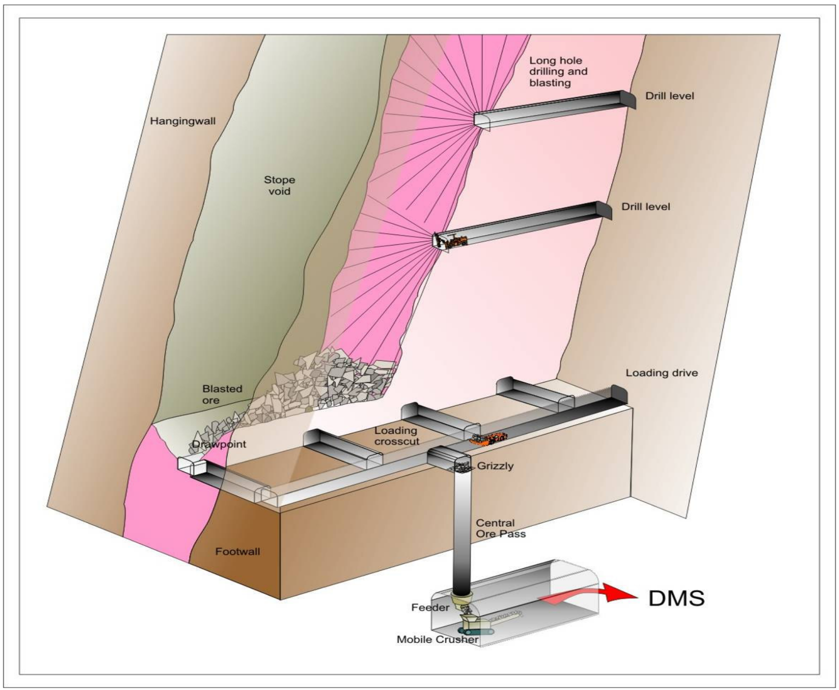

Figure 4 Schematic Sub-Level Open Stoping Layout

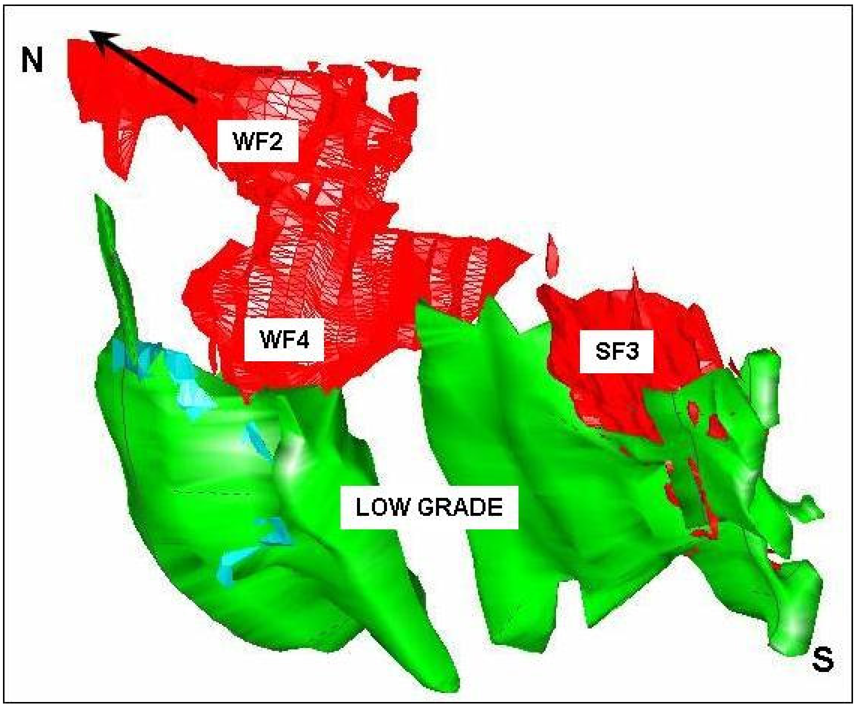

Figure 5 Geological Model of the Low Grade Ore Body used at Potential Level Phase[1]

For this mining method to be cost effective the mineralization in the ore body must be of a "bulky" nature i.e. delineation at different zinc and lead grades should produce large "able-to-mine" blocks of ore at a similar grade continuous in all directions, at least to the dimensions of the proposed stopes.

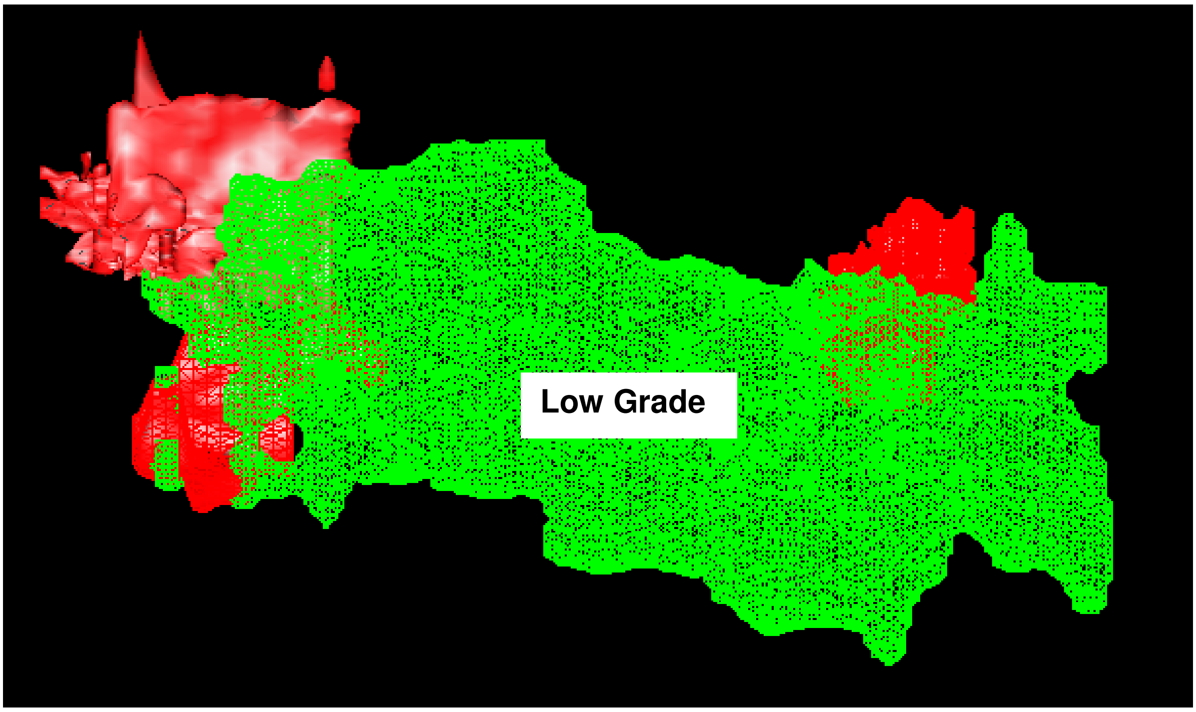

Figure 6 Geological Model of the Low Grade Ore Body at cut off grade of 1% Zn

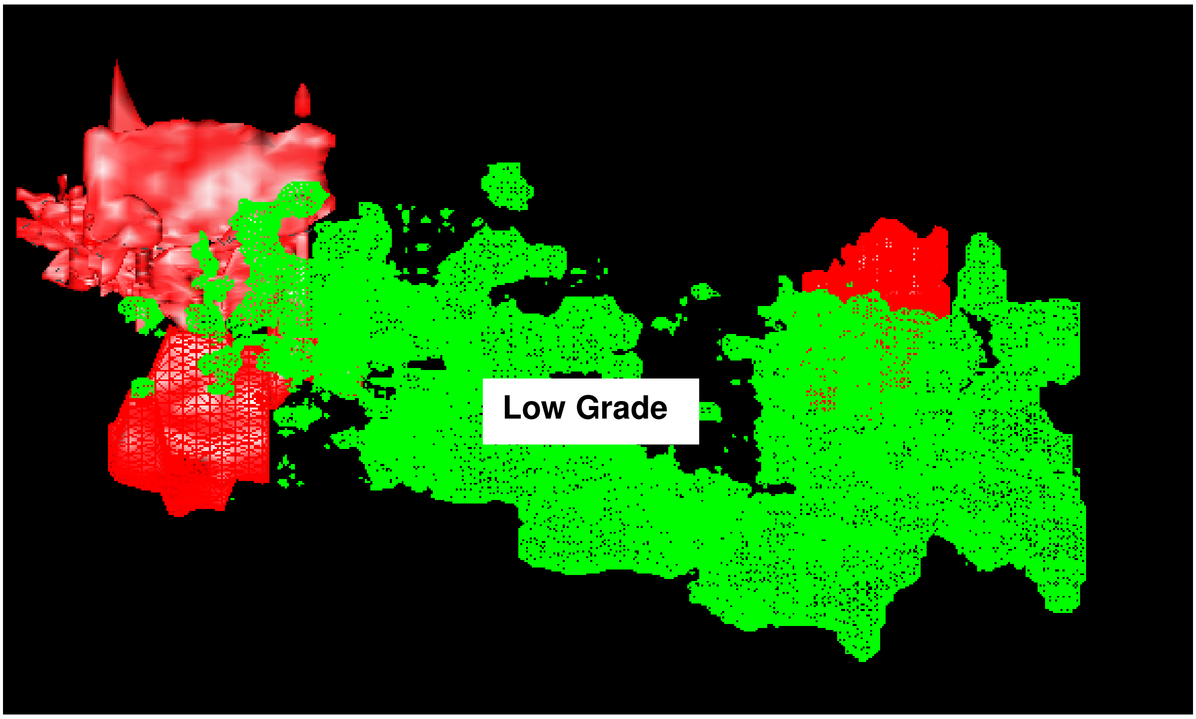

Figure 7 Geological Model of the Low Grade Ore Body at cut off grade of 2.5% Zn

The initial delineation of the low grade ore body during the potential study showed promise in terms of its continuous and bulky nature[1]. Figure 5 shows the low grade body being fairly continuous and of a massive nature, possibly amenable to bulk mining methods.

Further work that was done at feasibility level on the delineation of the low grade ore body gives a different picture as shown in Figure 6 and 7. With increasing cut-of-grade the low grade ore body starts breaking up into smaller pockets of mineralization less suitable for bulk mining methods. Depending on the payable limit of zinc determined during the pre-feasibility study, the mining method might need to be revised in order to mine the ore body economically.

Since not all projects are developed to the same level or amount of detail in the potential level study and due to the unique nature of each project, different potential show stoppers or fatal flaws will arise that should be resolved before proceeding with the engineering work on alternatives. The alternatives to be developed further will also look quite different once the potential show stoppers or fatal flaws have been resolved.

KEY VALUE DRIVERS

Along with the potential show stoppers, the key value drivers of the project assist the project team to find focus and direction. The concept of risk management using key value drivers was proposed by Mr Mike Rossouw[2]. The key value drivers are isolated by listing all elements that could have an effect on the net present value (NPV) and technical viability of the project. These include metal prices, sales tonnages, product grade, metal yield, production plan, capital cost, operating cost, loan repayments, et cetera. Each of these elements can be broken down into smaller constituents if necessary. Based on the business assumptions, each element will have a value or range of values over a time period. The values form the basis for the key value driver determination.

Table 1 Business case risk profile for some key elements of the sample project

Key Elements	Units	Best Case	Expected	Worst Case
R/US$ Exchange Rate	R/US$	8	7	6.5
Inflation	%/yr	4.5	5	7
Zn Price	US$/t	2000	1600	1000
Pb Price	US$/t	900	628	500
Zn Treatment Charge	US$/t	175	224	315
Pb Treatment Charge	US$/t	175	189	220
Moisture Content Zn	%	5	10	20
Transport Cost Zn	R/t	400	424	500
Moisture Content Pb	%	5	10	20
Wharfage	R/t	35	38.25	42
Transport cost Pb	R/t	200	250	300
Time to Market	Years	1	2	4
Ramp up Time	Years	1	2	4
Life of Mine	Years	12	10	5

For illustration some key elements of the sample project is used. Table 1 gives the business case values for the elements. The table gives three values for each element, namely best case, expected and worst case.

A Risk Workshop is held with all relevant stakeholders and technical experts to determine the realistic boundary conditions for each element given the all information available at that point. The worst and best case values are estimated and agreed upon by all stakeholders. This table is most critical and defines the risk profile of the project under question at that specific point. It is important to note that no NPV is calculated for the estimated values only and not for the worst case or best case using all values simultaneously. The probability is low of all values being at the worst or best case estimates.

A project uncertainty graph, constructed from the values in Table 1, gives the relative uncertainty of each element in relation to its business case value and relative to the other elements. Figure 8 shows the uncertainty ranges for each element from the sample project. The graph shows the worst case values in a light shade while the best case is shown in a darker shade with the value of the deviation indicated on the bar. The value is calculated using a simple formula:

Worst case % deviation = (worst case value – business case value) / business case value

and

Best case % deviation = (best case value - business case value) / business case value

It is evident from Figure 8 that there exists some substantial uncertainty around the ramp up time, time to market, and moisture content relative to the zinc price. The metal price has a nearly symmetrical spread of uncertainty while the uncertainties of some of the other parameters are skewed. The uncertainty shows where further work has to be done, but presents only part of the picture.

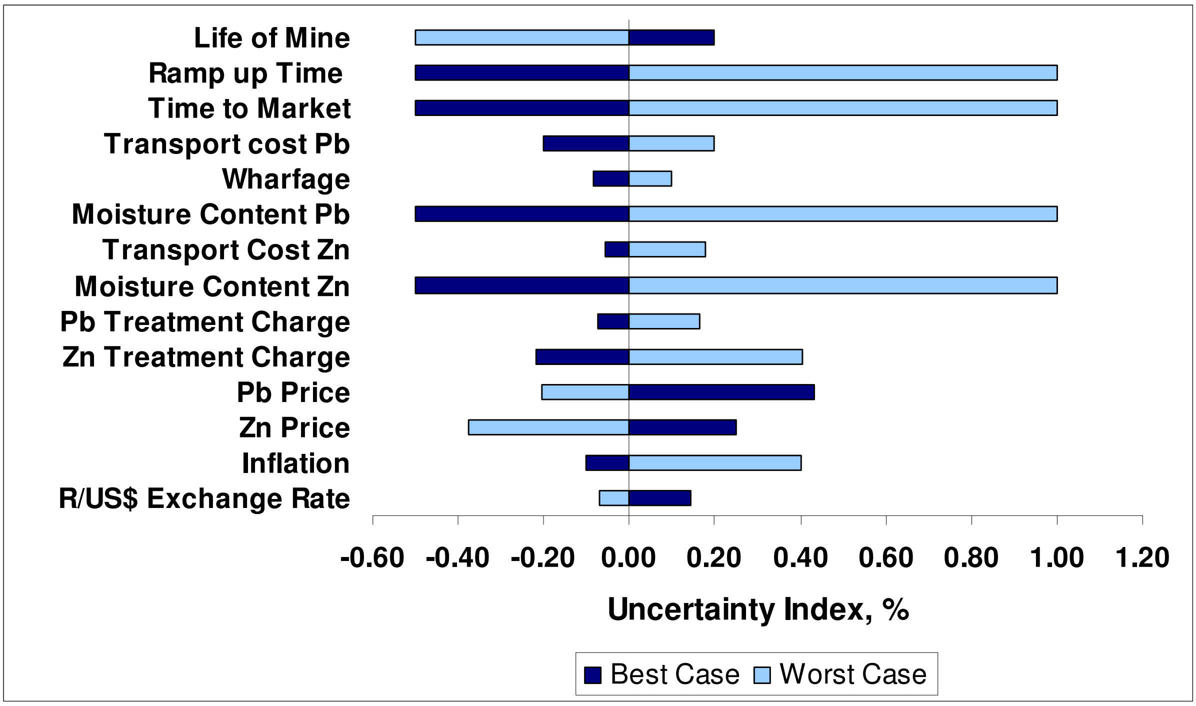

Figure 8 Project Uncertainty Index Graph*

To understand the financial impact of the project risk profile, a sensitivity analysis is done with the financial model to determine the impact on NPV of each deviation, both towards the worst or best case scenarios. Table 2 gives the impact on NPV (difference in NPV) from the base value as calculated for the business case scenario using the estimated values as in Table 1.

Table 2 NPV deviation (million N$) from base case for best and worst case values

Key Elements	Best Case	Worst Case
R/US$ Exchange Rate	254	-137
Inflation	34	-124
Zn Price	587	-630
Pb Price	152	-76
Zn Treatment Charge	169	-366
Pb Treatment Charge	14	-32
Moisture Content Zn	12	-22
Transport Cost Zn	15	-44
Moisture Content Pb	1	-2
Wharfage	1	-1
Transport cost Pb	6	-6
Time to Market	250	-500
Ramp up Time	100	-400
Life of Mine	200	-400

* **Graph constructed using Excel graph "Custom Types: Tubes"**

From Table 2 a project NPV impact graph is constructed shown in Figure 9. It shows the impact of each of the positive and negative deviations on the project NPV. The dashed lines on both sides of the zero value shows the quantified risk band management is willing to accept for the specific project (in the case of the example ± N$50m).

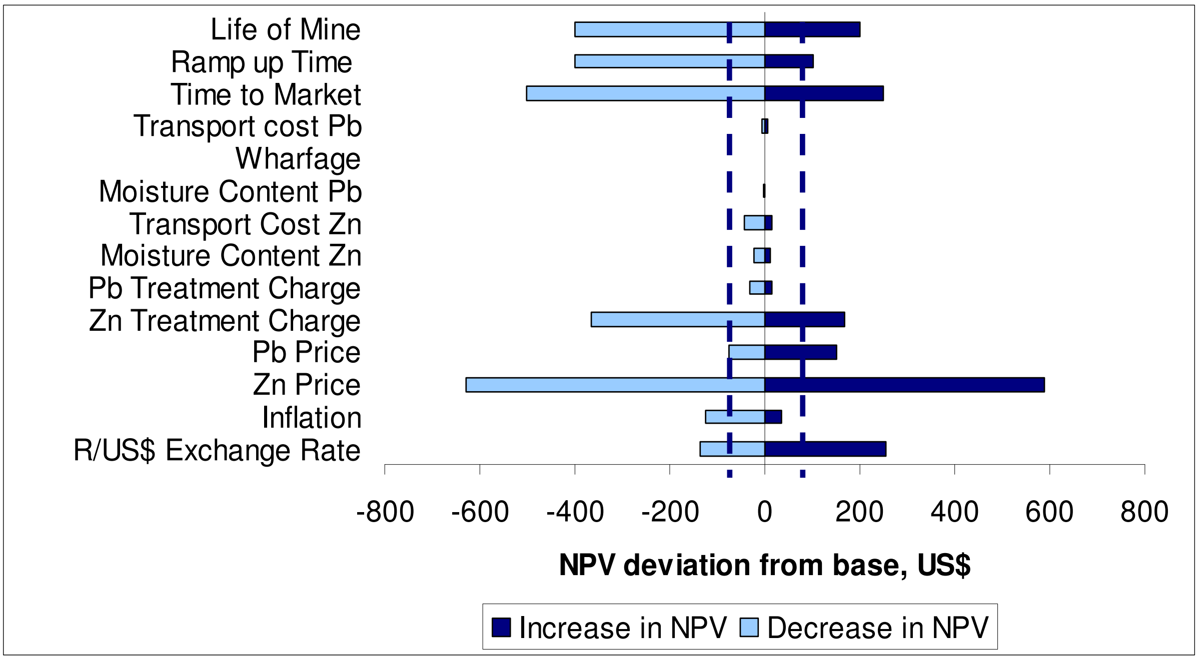

Figure 9 Project NPV Impact Graph

The management teams appetite for risk at a specific stage in the project, quantified by the dotted lines in Figure 9 highlights where resources must be allocated and focussed. The aim must be to decrease all ranges outside the boundaries to fall within the boundary lines.

The variables lying outside the risk band now becomes the key value drivers of the project. The project team allocated to the project can determine and quantify the cost, time and other resources required to decrease the uncertainty index of each key driver to fit within the boundaries of the NPV range specified by management.

In the case of the moisture content of the product (a controllable variable), the uncertainty range is large but the impact on the NPV very small compared to other elements and falling within the risk band. It thus becomes a technical consideration rather than a business impact consideration whether the moisture content must be addressed and at what stage in the project. In the case of the metal price (an un-controllable variable) the project will be jeopardised if the worst case estimate is to have effect. Conversely the project can make substantial profits if market conditions improve. Since the project team can do little or nothing about the metal price except to hope for a better forecast and eventual realisation of a better price, it becomes a management decision whether the project will take on the risk of the uncertain metal price.

It must be noted, that as further work is done the centre value of each variable will change and hence the project NPV as well. It could happen for example that the capital cost estimate could increase, but the worst and best case values should also come closer to this centre value. This could result in the business case NPV shifting to a lower value, but with more certainty around the variance.

In summary, the determination of key value drivers to facilitate allocation and focus of resources is done by utilizing the Risk Workshop to determine the project uncertainties. The uncertainties are translated into the impact on the business case and drivers are highlighted based on the risk the management team is willing to take at that specific point in the project life cycle.

TRACKING AND FEEDBACK

As a clear vision of the business strategy and understanding of the potential show stoppers and key value drivers enables alignment and focus of efforts. Tracking of progress and regular feedback by the project team to the executive and business unit forums enable assessment of projects against an ever changing environment. Failing to do so makes the business sluggish to react to the dynamic environment or change in information where a pro-active approach consequently becomes almost impossible.

Figure 10 shows a schematic diagram of a tracking and feedback communication model. In order to integrate information coming from the commodity business, business unit and project development environment, regular tracking and feedback forums and meetings need to be held. It is important that tracking and feedback occur in both directions.

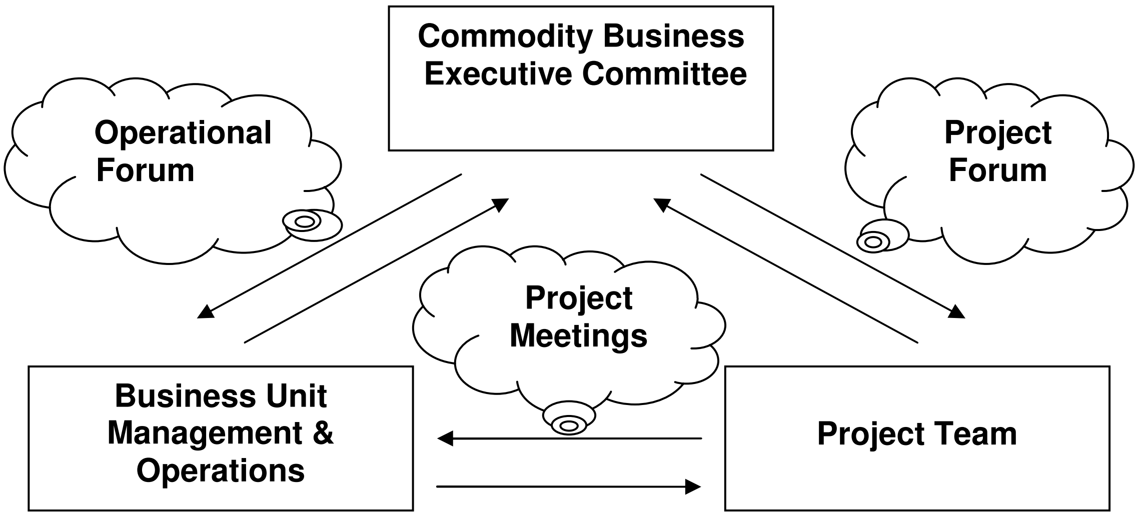

Figure 10 Tracking and Feedback Communication Model

The nature of communication will differ in each forum. The operational forum will focus on the business unit operations, the project forum on the high level progress and risk of projects and project meetings on resolving project specific matters in more detail.

By ensuring tracking of and regular feedback on the business, operations and project environment, the executive committee, business unit managers and project team can be pro-active and appropriate actions.

EVALUATION OF ALTERNATIVES

As part of the process of gaining and developing more information on potential show stoppers and key value drivers, alternatives to solutions will start crystallizing. These alternatives can be evaluated against one another using various tools and techniques, of which the most obvious is economic evaluation and technical viability.

A major problem in evaluating alternatives is that the impact of implementing a specific alternative often impacts on the rest of the value chain in complex and subtle ways that is not always obvious and could even be counter intuitive. This is where the concept of linear programming comes in to assist in evaluating alternatives based on a model of the business' value chain from mine face to metal order book. From a project perspective, the output of the linear programming method is the potential of a project / project alternative, expressed as the cumulative discounted cash flow for the business over the life of mine, compared to other projects or alternatives within a project. This method usually excludes the capital cost of projects.

Once the most profitable projects or alternatives are isolated, a detail financial model is built of each alternative to assess the influence of capital expenditure and other business factors to determine the overall NPV improvement over the business unit's base financial model. The result of following this process is an optimized business plan for the business unit incorporating the highest value projects and project alternatives. This allows allocation and focus of valuable resources on the highest value initiatives.

Linear Programming

Linear and Mixed Integer Programming (LMIP) is one of the tools Exxaro Base Metal uses to evaluate the best alternative solutions in a project and consequently across various projects. Large integrated mining and metallurgical complexes are modelled in their entirety in order to avoid sub-optimisation. The business plan is holistically optimised in terms of its objective function, typically, NPV. The optimisation exercise considers all possible combinations of plant, equipment, machinery, circuits, men and money in the planning process of exploiting the ore body:- ore resources (measured, indicated and inferred), through mining and beneficiation, up to the physical point of sale of the final product(s). The Rosh Pinah Zinc Corporation LMIP model matrix consists of around 48,000 variables and 47,500 equations.

The business plan for Rosh Pinah Zinc Corporation is built into the LMIP model with the relevant constraints put on the variables as defined by the business plan. The first LMIP model run is called the base case (BC in Table 3). The base case yields the BC cumulative discounted cash flow after tax ($CDCF_{BC}$). Subsequently various constraints can be lifted or changed allowing the incorporation of the effect of certain project initiatives to obtain the CDCF for each of these scenarios ($CDCF_{Senario\ i}$). An estimate of the potential NPV of the scenario could be obtained by the difference between the estimated capital expenditure required for the scenario and its ($CDCF_{Senario\ i}$- $CDCF_{BC}$) (the implied assumption is that the capital is expended immediately).

Table 3 LMIP and Financial Model Results for Different Project Alternatives

	CAPEX Estimate (N$ million)	$CDCF_{Senario\ i}$ – $CDCF_{BC}$ (N$ million)	NPV Potential, (N$ million)	LOM (years)	Incremental Enterprise NPV, (N$ million)
BC	-	-	-	10	
C1	250	150	(100)	7.5	
C2	100	250	150	8.5	30
C3	50	110	60	9.5	40
C4	350	125	(225)	7.5	

Given an estimate of the capital cost of each project alternative, the NPV potential of each alternative solution can be calculated by simply subtracting the capital estimate from the Potential Total NPV of each alternative.

Business Case Modelling

Once the business plan is optimized using linear programming, the plan is modelled in the business unit's financial model. Each project alternative will have its unique business plan and associated capital and operating cost requirements. The result would be a table listing the alternatives and the incremental NPV of each compared to the base case model as in Table 3.

This allows management to select the highest value projects and alternatives to be developed further. These models also form the next base model for determination of the key value drivers for the next phase of the project.

DECISION GATES

The last element in allocating and focussing resources during the early stages of the project development life cycle is management's ability to assess risk and make firm and quick decisions on the way forward.

The gate management governance at the decision point is key to managing the project development life cycle and will be unique for each company. Having set standards and governance provides guidelines to management enabling quick decision making.

This skill or ability of management to assess risk and make decisions is a factor the project team have little control over. The project team can however play a vital role in assisting the management team to understand clearly the key risk areas and the cost of either making the decision to go ahead or stop a project from continuing by closing the project and redirecting resources to the higher value projects.

By assessing the value, defining the critical parameters impacting on the business and ranking the project against other projects, the rate of development of projects can be increased. Delay in project progress can cause a “wait and see” attitude at the business unit level, while waiting for the result of the delayed project. This could cause them to delay other operational and sustaining projects. There again, opportunities to enhance and optimize current operations can be delayed or missed by spending time on potential non-viable projects.

The ability of management to make decisions regarding projects plays a vital role in this project prioritization process.

CONCLUSION

Various gaps and opportunities have been highlighted and key elements in the prioritization process proposed to assist in resource allocation and focus on the high value projects and alternatives during the early stages of the project development lifecycle. These include to define the project vision, objectives and business case, to determine the potential show stoppers, to determine the key value drivers, to track changes and provide regular feedback, to evaluate the alternatives and lastly to ensure proper gate management governance at the decision point.

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REFERENCES

1. H Fourie, PH van Rooyen, S Rupprecht, T Lund and NM Vegter, Exploitation of a Massive Low Grade Zinc-Lead Resource at Rosh Pinah Zinc Corporation, Namibia. In: SAIMM *Conference*: *Africa’s Base Metal Resurgence,* 23-27 July 2007, Swakopmund, Namibia.
2. M Rossouw, Risk Management and the role project managers play in the selection of the appropriate methods for your project requirements. *Conference: The Project Manager’s Conference,* Institute for International Research, 16-18 July 2007, Johannesburg, South Africa.
3. www.lslps.com - Website of LSLPS - "Large Scale Linear Programming Solutions"