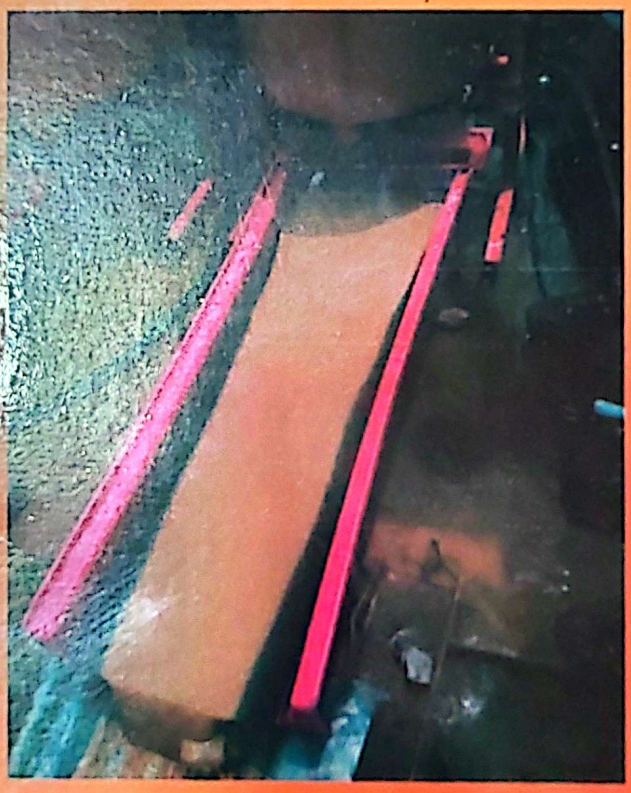
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Important Technical Considerations in the Development of Bankable Documents for Quarry Operations

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Abstract
Today's quarry operations are characterised by high capital expenditure, low product price and high operating costs including energy costs (diesel cost). Consequently, when deciding on quarry investment, there is little room for inefficiency in quarry design and production scheduling and, consequently, in the estimates of the quarry project's value. A doubtful and badly implemented quarry evaluation process could wrongly classify a non-profitable venture as being profitable with appreciable probability, and vice versa. And the consequence of a badly implemented quarry investment evaluation process has economic implications to both the promoters and stake holders of the project with financial institution (BOI[1]) inclusive. Many quarries financed by Nigerian banks record poor performances due to the technical flaws inherent in the so called Bankable Feasibility study reports submitted during the loan Application process. This paper suggests the need to engage competent hands (Mining Engineers /Mining Consultants) to carry out technical due diligence on every mining project funding or loan applications to guarantee effective and efficient funding of mining projects and justify BOI's contribution to nation's minerals industry. Also, engage team of engineers to monitor the performance of the quarry throughout the loan period. So as to ensure that the quarry run optimally to guarantee quick pay back and return on investment.
Key words: Bankable document, Technical flaw, Risk, Payback

1.0 Introduction

When an opportunity for opening/developing a quarry or acquiring an existing quarry opens, the promoter or the stakeholders of the quarry need to know the value of the quarry project and the cash flow that the quarry is going to generate over its useful life span. These are the basic determinant factors that can inform the decision to either proceed or not.

Mining projects, quarries inclusive are complex businesses that demand constant SWOT analysis influenced by many underlying economic and physical uncertainties, such as product prices, costs, schedules, capacities and environmental issues among others which are dicey. Hence, quarries present considerable challenge in effective assessments of capital expenditure, to those saddled with the responsibility of taking investment decisions such as Bank of Industry (BOI) and other investors alike.

To estimate the quarry project's value, the valuers will need to use sophisticated valuation techniques to assess, quantify and analyse existing risk and uncertainties involved in the project investment. Results of the evaluation processes guide the owners or stakeholders whether to start or abandon the quarry project. The result will also assist mine planners and quarry engineers to plan and design the quarry operation.

[1]Bank of Industry

The task of estimating the mine project's value is not so easy; a typical quarry project will depend on the characteristics of the deposit /reserve, product economics and operating costs of the quarry throughout its life span. Unfortunately, at the beginning of the project, enough information as to the nature and characteristics of the deposit is not usually available and product price behaviour and operating costs are based on historical data, which in most cases is

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not a good forecast of the future. This lack of information generates uncertainty about the values of the different underlying variables that take part in the evaluation process and consequently, the value of the quarry project.

1.1 Main sources of uncertainty in Granite Quarry projects

1.1.1 Uncertainty in Granite deposits:

One of the most critical sources of technical risk in granite quarry project lies in the quality of the rock to meet Engineering construction requirements and the tonnage of the deposit that will justify the proposed investment. Hence, reserve statement should not be an estimate of what is in-situ, but a prediction of what will be processed in the crushing plant. In the pre-feasibility study, the report is usually an information obtained from a skeletal exploration activity which is usually not a true representative of the entire property. It is then right to state that, if a deposit is yet to be mined, the knowledge of its geological characteristics, including quality and tonnage is limited and could lead to misclassification of resources. To minimise the misclassification, estimation techniques based on stochastic models are commonly used to estimate the geological information at non-sampled location. This is done by interpolating the data from few exploration samples (SME, 2011).

1.1.2 Uncertainty in product prizes and costs:

Another important source of uncertainty that has critical impact on quarry project evaluation is that associated with economic environment where the quarry is located. Within the environment, future prices and costs are the chief sources of uncertainty.

(a) Product prices: Any variation from the expected price (overestimation or underestimation) will modify the results of the entire project evaluation.

(b) Costs: Costs are usually classified as Capital costs, which refers to the investment required for the quarry's upstream and downstream equipment. Operating costs, which refers to the costs incurred in the production activities such as drilling and blasting, loading, haulage, equipment maintenance costs, and administrative costs which refers to the costs incurred in administration and other related activities in the quarry (Camus, 2002). The costs that are independent of the production level are regarded as fixed costs, while the costs that depend directly on the production level are regarded as variable costs. Since estimation of capital and operating costs are an important requirement for quarry evaluation, uncertainty in costs arises due to lack of engineering or economic information at the beginning of the quarry project. It is worthnoting to say that quarries do not know with absolute certainty today how much they will need to spend tomorrow, let alone next month or next year.

1.1.3 Uncertainty and risk is quarry planning and design:

The objective of quarry (pit geometry) design is to determine the projected final pit limits of granite deposit and its tonnage in order to maximize the economic value of the quarry while satisfying operational constraints such as crushing plant capacity and slope angles (Hustrulid and Kuchta, 1995; Dowd and Onur, 1993). The complete process of designing a quarry consists of two principal stages: pit geometry design where the ultimate pit limits are established and contoured; and production scheduling where the sequence of quarrying is planned over time.

The ultimate pit limit is the widest possible boundaries within which all subsequent quarrying operations are performed while maximizing Net Present Value (NPV). Production scheduling is the development of a sequence of extraction

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schedules from the initial state of the deposit to the ultimate pit limits. According to the tenure of scheduling, the production scheduling can be classified into long-term or short-term scheduling. Long-term is the schedule based on cash flow analysis and provides a guide to a more detailed quarry design and development. Short-term is the development of a sequence of extraction schedules on a daily, weekly or monthly basis within the layout of the quarry. Short-term scheduling ensures the achievement of production targets established in the long-term. Since both the ultimate pit limit and production scheduling depend directly on the granite deposit, future product prices and costs, uncertainty and risk in quarry planning and design arise due to the uncertain nature of the underlying variables that take part in the designing and planning process. It then implies that allocation of the physical limits of both the ultimate pit and long term production forecast turns into a complex and uncertain process since it depends on both the uncertainty of future product prices and false reserve estimation.

1.1.4 Uncertainty and risk in Quarry project operation and management: *"Statement of the problem"*

From the previous sections, the evaluation of a quarry project is a complex process. It involves not only the economic uncertainty of future product prices and costs, but also the technical uncertainties in which both the geological characteristics of the deposit and the designing and planning of the quarry pit geometry are considered. Furthermore, the evaluation of a quarry also involves the different operational strategies that are adopted throughout the operating life of the quarry to enhance the reliability of the quarry process for optimal production.

Quarry industry has received a great number of funding from BOI and other banks, though the quarries created thousands of jobs resulting in significant reduction in unemployment in the minerals industry, as well as projected increase in

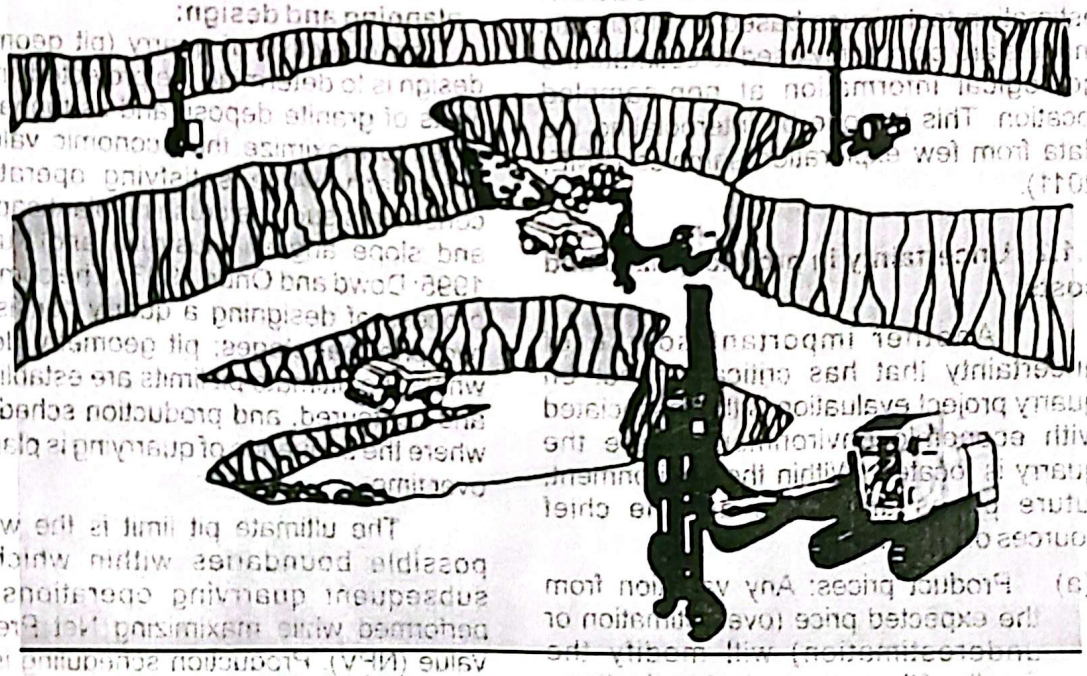


Figure 1: A Typical Pit- type quarry layout (Source: Atlas Copco, 2008)

the wealth and growth of the nation's economy, they bear a high risk in achieving their forecast profitability through maintaining budgeted costs. Most of the problems encountered in the quarries stem from lack of proper evaluation of the quarry design integrity (Abdulraman, 2016). Investigations revealed that most of the quarries have either exceeded their budgeted establishment costs or have experienced operational costs far in excess of what was originally estimated in their feasibility study reports. These lead to the quarries not able to run optimally resulting in elongated pay back and poor return on investment.

This paper provides an overview of quarry management as a guide for financial experts to be acquainted with the operational factors that are capable of elongating the payback period or could lead to premature abandonment of a quarry project.

2.0 Typical Aggregate Quarry Process

A quarry can simply be defined as a factory where solid bed rock is converted to dimensioned / crushed stones. A quarry can either be mountainous (Hill side) or pit type. The pit type quarry is opened up below the level of surrounding terrain and accessed by means of ramps. The excavated rock is crushed, screened and sometimes washed into different size fractions for subsequent sales and use.

Research have shown that pit type quarries record more development and operating costs than the hill side type except, where in-pit crushing is adopted (Eloranta, 2006). A typical aggregate quarry process is a batch process of drilling, blasting, loading, haulage, crushing, screening, stockpiling and material handling (Figure 2). These processes can be classified into upstream and downstream sections. As such, low productivity in upstream will filter through to downstream.

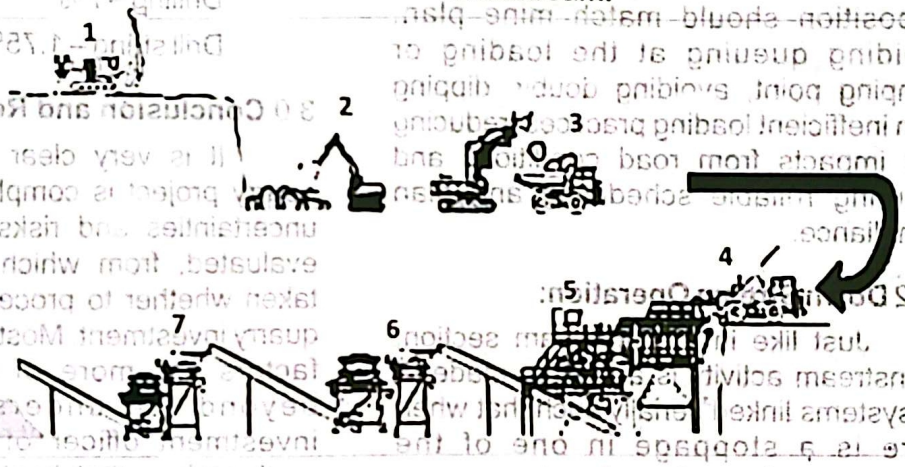


Figure 2:Aggregate Quarry Processes (Source: Abdulraman, 2016)
1 - Drilling; 2 - Mechanical Breaking; 3 - Loading and Haulage; 4 - Dumping and Feeding; 5 - Primary Crushing; 6 - Secondary Crushing; 7 - Screening and Classification; 8 - Storage/ stockpile.

2.1 Critical factors for the realization of the goal of quarry investment

2.1.1 Upstream Operations:

(a) Quarry pit optimization

Appropriate pit geometry design will enhance operational flow and consequently lead to optimum production.

(b) Extraction methodology

Drilling and Blasting design should ensure maximum production at reasonable cost. The drilling facility must be reliable, if the drilling rig is not performing optimally, it

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will affect the blasting schedule and post a challenge to the quarry in achieving optimal productivity. Blasting operation should provide material with good fragmentation. Blast problem can add 10 - 25% to downstream cost (PwC, 2012) through damages to equipment fleet, granite deposit, mine plan; inefficient processing at the crushing plant; and wastage of explosive for rework (Secondary blasting).

(c) Fleet productivity and fit

The selection and acquisition of loading and haulage facilities must be based on engineering analyses and not the purchase price. Inefficient loading can increase the quarry operating cost as a result of delay in deliveries to the crushing plant; inefficient loading will also lead to ineffective cycle time and utilization of that fleet. Haulage facility is a critical success factor to aggregate quarry process. For operational effectiveness, haulage facility size must match loading facility size; fleet disposition should match mine plan, avoiding queuing at the loading or dumping point, avoiding double dipping from inefficient loading practices, reducing tyre impacts from road conditions and ensuring reliable scheduling and plan compliance.

2.1.2 Down Stream Operation:

Just like in the upstream section, downstream activity is a system made of subsystems linked serially such that when there is a stoppage in one of the subsystems, the entire subsystem comes to a hurt. In an aggregate quarry, the layout of the crushing plants and ancillary equipment and structures is a critical factor in meeting production target/requirements while keeping capital and operating cost to a minimum. Crushing plant optimization begins with appropriate design of flow line whose installation meets the required production output, operates at competitive cost, complies with today's tough environmental regulations and can be built at a reasonable price despite the rising costs of equipment, energy and construction labour. There are three steps in designing a good crushing plant: process design; equipment selection; and layout. The first two are dictated by production requirements and design parameters, but the layout can affect the reliability and maintainability of the process with resultant plant optimizations. Running a plant optimally require keeping records of operation for Pareto analysis of failure occurrences. This will identify the critical subsystems that require improvement through appropriate maintenance policies to enhance productivity. A typical cost distribution at quarries is reported by Atlas Copco (2008) as stated below:

Crushing, Screening and Storage – 50%

Loading and Haulage – 25%

Blasting – 16.25%

Drilling – 7%

Drill string – 1.75%

3.0 Conclusion and Recommendation

It is very clear that evaluating a quarry project is complex with numerous uncertainties and risks that need to be evaluated, from which decision can be taken whether to proceed or not with the quarry investment. Most of the determinant factors are more of technical issues beyond the understanding of an investment officer of any bank. It is pertinent here that, banks with interest and mandate in mining investment to engage the services of experienced and competent mining consultants as lender's engineer for their portfolio of quarry projects for a thorough technical due diligence, which could guarantee a hitch free pay back of the quarry investment, thereby encouraging more public funds into the industry.

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