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PRIORITIZING CRITICAL FACTORS INFLUENCING MINING INVESTMENT DECISIONS USING AHP

Akankika Tripathy[1]* and Prof. Debendra Kumar Mahalik[2]
Department of Business Administration, Sambalpur University, Odisha, 768019

ABSTRACT
The coal mining sector plays a pivotal role in the economy as it supplies vital energy resources to different sector of the economy. The investment decision making in this domain is highly complex as it involves large scale investment, long gestation period, irreversible investment and multiple uncertainties. These characteristics of the investment decisions make it imperative for the coal mining organisations to have a robust and comprehensive framework of decision making. However, this investment decision in the complex driven mining sector is majorly influenced by different traditional financial appraisal tools which although provides valuable insight about the financial feasibility of the projects but often are limited in their ability to consider the multi-dimensional aspect of decision making. These limitations have motivated the present study which focus on evaluating the criteria majorly influencing the current investment decision making in mining sector by taking a case study of Mahanadi Coalfields Limited, major subsidiary of Coal India Limited using the novel AHP model.

Keywords: *Investment decision making, Coal mining Industry, AHP*

INTRODUCTION
Industry-specific capital investment decisions refer to the strategic allocation of financial resources by companies within a particular industry toward projects that are expected to generate long-term benefits (Chung, 1993; Coleshill & Sheffield, 2000; Nalwade & Parakh, 2013; Farhan, 2024). These decisions are critical for enhancing profitability, maintaining competitive advantage, and ensuring the long-term sustainability of operations. And these investment decisions in the coal ming sector is highly complex as it involves large scale investment, long gestation period, irreversible investments and multiple uncertainties. Considering the critical nature of these decisions particularly in mining sector, it becomes imperative for the industry specific companies to have a robust and comprehensive investment decision making framework. However, the investment decision making in this sector is still dominated by the traditional and strategic financial appraisal tools. Although they provide valuable insight about the financial feasibility of the investment alternatives but they often fail to consider different other variables influencing the decision making (Abdulsamad & Sheshaheruddin, 2009). One of the greatest weaknesses of conventional capital budgeting techniques is their limited financial orientation. As (Bennouna et al., 2010) noted, traditional techniques tend to miss non-financial and strategic considerations like environmental sustainability, regulatory updates, or social impact. In sectors such as mining, where long-term viability and stakeholder management are critical, this omission can lead to decisions that maximize short-term financial gains at the expense of long-term strategic objectives. Moreover, Investment decisions in mining involve evaluating a wide range of scenarios, such as whether to develop new mines, expand existing operations, or invest in new technologies for efficiency and compliance. In order to address these limitations, the present study evaluates the variables still considered during the decision-making process of coal mining industry.

The present study evaluates the variables that are majorly contributing to the mining investment decision in order to have a better understanding of these investment decisions and to overcome the limitations of the existing approaches by integrating multidimensionality framework. For this objective the study has taken a case study of MCL, as it been one of the major coal producing subsidiaries of Coal India limited, and evaluated the contributing variables using AHP model considering the expert's opinions who are directly involved in the process.

LITRATURE REVIEW
India is endowed with a wide range of mineral resources and ranks among the top global producers of coal, iron ore, bauxite, and manganese. However, despite the abundance of natural resources, the contribution of the mining sector to India's GDP has remained stagnant hovering around 2.5% for over a decade (Dorian, 2006). This underperformance can be attributed to a combination of structural inefficiencies, policy delays, and ineffective capital deployment in both public and private mining entities.

The public sector dominates India's mining landscape. While these organizations account for a substantial share of national production, their capital investment decision making practices are shaped not only by profitability metrics but also by governmental mandates, employment generation targets, and regional development goals. Several empirical studies have examined the use of capital investment decision making techniques across Indian

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industries, with a focus on capital-intensive sectors like mining. (Singh et al., 2012) found that Indian companies have adopted sophisticated evaluation techniques such as Net Present Value (NPV), Internal Rate of Return (IRR), and Real Option Analysis (ROA), especially for large-scale, long-gestation projects. In their sample of large Indian firms, over 75% used IRR, while 50% employed NPV in combination with traditional methods like the payback period. (Verma et al., 2020) similarly found that 90% of surveyed companies used multiple appraisal methods, indicating a shift toward hybrid approaches. The internal qualifications and experience of financial managers were found to directly influence the use of advanced techniques. CIL, as the largest coal producer in the world, has extensive capital investment plans that are reviewed at both central and subsidiary levels. While projects are evaluated using DCF techniques like NPV and IRR, many decisions are politically driven, with social and employment objectives overriding strict financial metrics. Although tools like internal rate of return are mandated, their use may sometimes be more ceremonial than analytically rigorous, especially when projects are backed by public funds.

In this regard, (Mohamed, 2013) argued that discounted cash flow techniques are not helpful for the high-tech, knowledge-based sector of the economy. Because these kinds of firms invest less on tangible assets and place more emphasis on Research & Development, Marketing, Training, Software, and other intangible assets, which are hard to justify using conventional capital budgeting tools. (Brajkovic, 2010) also argued that researchers and practitioners are dissatisfied with discounted cash flow techniques as they do not properly deal with the issue of risk and flexibility present in investment projects. (Trigeorgis & Tsekrekos, 2018) contend that these approaches leave little space for adaptation or flexibility, which is especially challenging in industries where commodity prices, regulatory regimes, and technological breakthroughs change quickly.

Overall, although traditional and discounted capital investment decision making methods have their advantages, their shortcomings above all else, managing risk, uncertainty, and strategic factors require sturdier, more flexible tools for investment decision-making. Given the mining industry's situation, where projects are capital-intensive, risk-ridden, and long-term, there is a greater need for a more comprehensive approach to secure solid and sustainable investment decisions.

RESEARCH OBJECTIVE

The current study aims to evaluate the major criteria that have an influential roll in the investment decision making process and their relative importance from the decision maker’s prospective in order to have a clear understanding of the decision-making framework in coal ming sector. These study of prioritization can form the basis to study the limitations of the existing framework and to develop a model that will improve upon the existing one.

RESEARCH METHOD

The study uses the basic AHP model to evaluate the prioritization of factors in investment decision making in mining sector.

Analytical Hierarchical Process:

AHP organizes complex decision-making by breaking the problem into a hierarchy of levels. At the top level is the main objective, which in this case is to determine the best investment option among several potential project alternatives. The level beneath this goal is composed of key factors and their respective sub-factors, each contributing toward achieving the primary objective. Here, it’s been used to evaluate the level of significance of different factors and sub-factors that represent various dimensions relevant to the decision-making process, such as financial, technical, environmental, or social considerations

The method suggested by Saaty for the Analytical Hierarchy Process can be summarized into the following steps;

Table 1 The ratio scale and definition of AHP (Saaty 1990)

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Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
5	Much more important
7	Very much more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values

The AHP methodology begins by clearly identifying the decision problem and establishing the main objective. This initial phase involves articulating the purpose of the decision, such as choosing the most suitable investment alternative or ranking different options by priority. Following this, a hierarchical structure is developed, placing the overall goal at the top level. Beneath it, the essential criteria and sub-criteria influencing the decision are organized. Subsequently, elements at each level of the hierarchy are compared in pairs to evaluate their relative significance. Decision-makers use Saaty's 1-9 scale to express the degree of preference or importance of one element over another, encompassing criteria, sub-criteria, and alternatives.

Using the results from the pairwise comparisons, priority weights for each criterion and sub-criterion are computed. This involves calculating normalized weightings, or eigenvalues, which represent the importance of each factor in the decision-making process. To ensure the reliability of the judgments, a Consistency Index (CI) and Consistency Ratio (CR) are calculated. If the CR falls below a commonly accepted threshold (typically 0.10), the judgments are deemed consistent; otherwise, revisions to the comparisons are necessary. Finally, the aggregated priority weights across all hierarchy levels allow for the evaluation of decision alternatives. This synthesis provides a weighted score for each option, reflecting the overall influence of the criteria and sub-criteria on the final decision.

In the context of this research, the Analytic Hierarchy Process (AHP) enables a structured and systematic prioritization of the various criteria influencing capital and mining investment decisions. It facilitates the integration of expert knowledge by converting qualitative judgments into quantitative weights, ensuring that decision-making reflects both practical experience and analytical rigor. AHP allows for the decomposition of complex decision factors into a hierarchical model, making it easier to evaluate and compare diverse criteria such as financial performance, environmental compliance, and operational feasibility. It also ensures consistency in responses through the calculation of a consistency ratio, adding reliability to the results. By assigning relative weights to each criterion based on expert pairwise comparisons, AHP provides a transparent and replicable basis for further decision-making

Problem Identification:
Here we have identified different criteria of MCL contributing the mining investment decisions from the literatures and the budgetary & annual reports of MCL. After identifying the factors, they have been prioritized based on their importance to the decision-making process, which has been derived from the discussion with experts of finance and project & planning departments of MCL and the Saaty Scale based data collected from them. This weightage of factors helped us to deduce the priority of each criterion and its sub-criterion as described by the AHP process above.

As suggested by (Mukherjee & Bera, 1995; and Setiyawan et al., 2020), investment decisions in the mining industry are influenced by a complex interplay of various factors. These factors, which form the core of the decision-making framework, include:

i. **Capital Investment (M1)**: The initial investment made for setting up the mining operations including the finance required to cover the fixed and variable cost.

ii. **Cash Outflow (M2)**: The total money spent on all the expenditure involved in a particular project, including operating expenses, maintenance costs, and other ongoing financial commitments.

iii. **Sales (M3)**: It is the regular revenue that is generated from the sale of outputs generated from the project which is important indicator of financial viability of the investment.

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iv. **Cost of Production (M4)**: The cost directly associated with production process and in mining industry particularly relating to extraction and processing of coal, including labour, materials, energy, and equipment.

v. **Profit (M5)**: The overall financial gain realised from the sales and operations relating to the project.

vi. **Discounted Cash Flow (M6)**: Indicates the present value of the different expenses and revenue earned from the operation.

vii. **Net Present Value (NPV) (M7)**: It measures the financial feasibility of a project by comparing the initial investment to the present value of revenue of the project. NPV is a critical factor in determining whether an investment will yield a positive return.

viii. **Net Cash Flow (M8)**: Net Cash flow indicate the liquidity of a project through the difference between cash inflows and outflows.

Based on above said criteria and their tributaries, we have collected the opinions from the Experts who are involved in the investment decision-making process of MCL about their experience and expertise. Thereafter pairwise comparison matrix developed from the expert opinions and weight-based priority of each criterion has been derived.

ANALYSIS AND RESULT

To gain insight into the investment decisions within the coal industry, we consulted decision-makers from both the finance and project & planning departments. These personnel were asked to share their views on the key factors that influence and shape investment decisions. Based on their expertise and input, we analysed the prioritization and investment patterns specific to the coal industry using the Analytical Hierarchy Process (AHP). This approach allowed us to systematically evaluate the importance of each factor, shedding light on the strategic considerations driving MCL's investments. Once the problem and the key criteria influencing overall decision-making were identified, input from a group of eight experts at Mahanadi Coalfields Limited (MCL) was gathered and integrated into the study. Using the scale-based data provided by these experts, a pairwise comparison matrix was constructed. After normalizing the matrix, the priority vectors (Table 2) for each attribute were calculated, enabling us to determine the ranking of these factors based on their relative importance. This process helped in establishing a clear prioritization framework for decision-making.

Table 2: Prioritization sequence of attributes to mining investment decision

Criteria	M1	M2	M3	M4	M5	M6	M7	M8	Weights	Prioritization
Capital Investment (M1)	1	2.874102	2.446776	1.852959	1.036554	1.944202	0.9754	3.348995	0.201536	2
Cash outflow (M2)	0.3479347	1	1.722555	0.255226	0.601753	2.331947	0.389521	3.191825	0.097941	5
Sales (M3)	0.408701	0.408701	1	0.444502	0.389521	2.728217	0.679183	3.918093	0.095049	6
Cost of Production(M4)	0.5396772	0.539677	2.249711	1	0.439641	3.734215	0.141214	2.728217	0.103481	4
Profit(M5)	0.9647347	0.964735	2.567259	2.274582	1	3.918093	0.580533	2.693674	0.179053	3
Discounted cashflow (M6)	0.5143499	0.51435	0.36654	0.267794	0.255226	1	0.402596	0.332943	0.048001	8
NPV (M7)	1.0252204	1.02522	1.472357	7.081469	1.722555	2.483882	1	3.734215	0.220337	1
Net Cashflow (M8)	0.2985970	0.298597	0.255226	0.36654	0.37124	3.003515	0.267794	1	0.054603	7

λ max =8.561195, CI=0.080171, RI=1.41, CR=0.056859 < 0:1 OK.

The pairwise comparison matrix and the priority value indicates that the NPV to be the most influential criterion to the mining investment decision followed by capital investment and profit. These results indicated that the coal mining sector is still relying upon the financial indicators like NPV, IRR for their investment decision even though they are influenced by highly complex and uncertain environment. However, this structured evaluation of influencing variables to mining investments provides a comprehensive insight, with due consideration to key criteria both financial and non-financial simultaneously. The prioritization allows decision-makers at MCL to allocate resources more effectively and ensures a balanced approach by addressing operational variables for mining investment decisions.

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CONCLUSION

The Analytical Hierarchy Process (AHP) served as a foundational tool in identifying and prioritizing the critical factors influencing capital and mining investment decisions at Mahanadi Coalfields Limited (MCL). By structuring the problem into a hierarchical model and using pairwise comparisons based on expert input, the study was able to derive relative weights that reflect the perceived importance of various investment criteria. The AHP results revealed a distinct preference for financial parameters such as Net Present Value (NPV), operational efficiency, and production capacity, highlighting the continued dominance of traditional financial logic in capital investment decisions.

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