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A Comprehensive Decision-Making Framework for Capital Investment in Coal Mining: Insights from Mahanadi Coalfields Ltd

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ABSTRACT

Purpose: Investment decision-making is essential for shaping the trajectory of industries, especially in sectors with substantial impacts on national economy. Likewise, the coal industry, being the second largest contributor to world energy production and a major part of Indian economy, bases its operational and financial efficiency on investment decisions but rather considering the need for more strategize approach it still adapting the year-old traditional methods to investment decision making process which affecting the overall efficiency amid uncertainties, risks, and diverse criteria. These limitations motivated this study, that focuses on with insights from Mahanadi Coalfields Ltd., proposes a comprehensive framework for strategic investment decision-making in the coal mining sector and exampled with a case study.

Approach: The study considers the existing investment decision-making framework within the complexities of a multifactorial decision-making environment. It employs an integrated AHP-TOPSIS method is utilized, where weights are assigned to the identified components using AHP, and TOPSIS is applied to identify the most efficient investment projects based on the components impacting the decision-making process.

Findings: The study offers a structured method for evaluating investment opportunities, aiding decision-makers in optimizing resource allocation. By aligning investments with organizational goals, the framework ensures maximized returns and contributes to overall efficiency in the coal mining sector.

Originality Value: This study is unique in a way that it proposes a novel application of an integrated AHP-TOPSIS approach to investment decision-making in the coal industry. It provides a strategic framework that addresses the unique challenges of multifactorial decision environments, offering significant value to both researchers and practitioners in the field.

Keywords: Mining company, Investment decision making, AHP, TOPSIS

1. Introduction:

Investment decision-making is essential for shaping the trajectory of industries, especially in sectors with substantial impacts on national economy. The coal industry, being the second largest contributor to world’s energy production, involves in investment decision making impacting the operational and financial efficiency of the organisation amid uncertainties, risks, and diverse criteria. But this decision-making process still rely upon the year-old traditional approaches, that has some drastic limitation impacting the overall efficiency. So, firms must have a strategic investment decision making process regarding capital investments which has some unavoidable and long-lasting effect on productivity and survival. (Peterson and Fabozzi, 2002, Cooper et al.,2002; Dayananda et al,2002)

There are two main categories of conventional investment decision-making approaches now in use: traditional approaches and strategic approaches. Future cash flows and the time worth of money are frequently overlooked by conventional techniques like the payback period and average rate of return. However, while taking into account expected cash flows and time value of money, strategic approaches like Internal Rate of Return (IRR), Net Present Value (NPV), and Modified Internal Rate of Return (MIRR) underestimate the future added value of these alternatives and ignores the associated risks. Numerous studies that examined various decision-making techniques and applied them to investment decisions involving the real option approach multi-criteria decision-making approach, outranking approach, system dynamics, and many other approaches have been spurred by these disadvantages of strategic approaches.

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But because of the multifaceted nature of these decisions, encompassing financial, operational, and strategic considerations, a robust decision-making framework becomes indispensable. This study addresses this need by proposing a carefully structured decision-making approach that integrates diverse criteria to evaluate alternative investments in the energy sector, the integrated AHP-TOPSIS method has been implemented for systematic structuring and prioritization of decision criteria (AHP) along with determination of rank of the competitive option with regards to their distance from the ideal solution using TOPSIS, offering a comprehensive and effective methodology for investment decision-making in the coal industry.

In this study, we propose to apply the AHP-TOPSIS method to investment decision making by taking a case study of Mahanadi Coal Field Ltd., a subsidiary of Coal India Limited. By incorporating both quantitative and qualitative factors and considering the complex interrelationships between them, this approach aims to provide valuable insights for optimizing its investment portfolio and driving sustainable growth in the coal mining sector.

2. Literature Review

One of the most important decisions an organization has to take is how to allocate its resources among the competitive investment opportunities. This decision affects the firm's profit and should be made after careful consideration of the criteria that drive the investment structure and the relationships between them. (Filipishyna et al., 2020) A strong project planning and finance management system is essential for enabling the mining industry to deliver superior products and a sustainable economy. So there is a need for carefully structured investment decision making framework. But these coal mining companies are still depending their decision on the year-old sophisticated investment decision making methods like IRR, NPV, MIRR. All of these strategic approaches place a strong emphasis on the investment's cash flow, associated risk and the time value of money into account. But the main flaw in these methods, as found in numerous studies, is that they don't account for an investment project's volatility and are unable to assess situations in which there is insufficient data for the future. (Dixit and Pindyck, 1994; Brennan and Schwartz, 1992; Trigeorgis, 1993) Although various approach like game theory, real option approach has become tool to decision making (Ankum & Smit, 1993) but considering the multifactorial nature of the investment decision MCDM can be a significant tool for selecting an efficient investment opportunity.

(Mukherjee & Bera, 1995) Some of the factors influencing the project selection decision framework have been identified in their study to develop a strategy for project selection in the Indian coal mining sector using goal programming. Based on the expert's assessment and rating, these criteria are assessed to determine the relative relevance of the same and the alternative decision options are also assessed to determine the most cost-effective capital investment opportunity. Goal programming-AHP technique has also been used by (Setiyawan & Ciptomulyono, 2021) as a means of choosing the best project investment option in coal power plant taking availability, reliability, efficiency, and safety as contributing attributes for investment decisions and by assigning weights they to them they suggested most effective investment option.

The combination of AHP and TOPSIS has been an efficient tool to cater the complex decision-making problems. It has been a tool to various complex decision-making problems like supply chain management and service quality. The integrated AHP-TOPSIS is a comprehensive decision-making approach, which combines the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Amiri, 2010). It has been used in various area of study like IT project portfolio prioritization (Ghasemzadeh et al, 1999), water loss management (Amiri, 2010), information technology selection (Amiri, 2010), selection of projects for developing oil-fields (Barda et al, 1990), and participatory budget project rankings (Amiri, 2010). For Amiri (2010) suggested an approach employing fuzzy TOPSIS and AHP for the National Iranian Oil Company so as to identify the projects that are beneficial and empower the decision maker to choose among them. The issue of selecting project has been supported by AHP, and by factor weights that are assigned to identified variables; and lastly the ranking has been associated to the projects by the extensive method of fuzzy TOPSIS in their study (Amiri, 2010). Depending on objective and constrains of an organisation, (Ghasemzadeh et al, 1999) proposed the AHP-TOPSIS technique in order to choose and implement an best project portfolio (Valadan et al, 2013). AHP-TOPSIS has also been a technique for identification and selection of power plant locations like Barda et al. (2014) suggested the choice of best location for a thermal power plant using the ELECTRE III technique along with AHP (Zhou et al., 2016). Moreover (Choudhary & Shankar, 2012) has employed AHP-TOPSIS and GIS approach for locating alternative sites to develop thermal power plant. Although being emerged as an effective tool, integrated approach of AHP and TOPSIS, it has not yet been utilized for investment decision-making in the coal mining sector.

3. Research Gap

The extensive literature review highlights several research gaps, including the need for moving towards more comprehensive method for investment decision that will overcome the limitation of project volatility and uncertainty, the exploration of MCDM frameworks in investment decision- making, and the application of combined AHP-TOPSIS methodologies within the coal mining sector. Addressing these gaps could enhance the effectiveness and efficiency of investment decision-making processes in coal mining companies

4. Research Objectives:

The basic objective of this paper includes extensive understanding of the investment decision-making process of Coal Mining industry by analysing the key factors influencing investment choices and the systematic prioritization of the same based on their relative importance and stakeholders' preferences. Also the objective includes proposal of a structured approach to decision making and to evaluate the investment opportunities with regards to their distance/closeness to the ideal solution, considering the criteria prioritized through AHP. Moreover, to evaluate the effectiveness and practical applicability of AHP-TOPSIS approach in optimizing investment decisions within Mahanadi Coal Field Ltd., considering multiple attributes. By the proposed approach the present study aims at providing actionable insights and recommendations to coal mining company based on the outcomes of the AHP-TOPSIS analysis, facilitating informed and strategic investment decisions aligned with the company's objectives and stakeholder interests.

5. Research Methodology

a. Research Problem:

The research problem addressed in this study is the development of a robust investment decision-making framework specifically tailored to the unique needs and challenges of the coal mining industry. The primary focus is on optimizing investment choices within a fluctuating and complex environment. This involves navigating the inherent uncertainties and risks associated with capital-intensive projects, ensuring that investment decisions are both strategic and sustainable. As suggested by (Mukherjee et al., 1995; De Souza et al., 2018 & Setiyawan et al., 2020), capital 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:

- **Capital Investment (C1)**: The initial capital required for the project, encompassing both fixed and variable costs associated with setting up and maintaining mining operations.
- **Cash Outflow (C2)**: The total expenditure involved in the project, including operating expenses, maintenance costs, and other ongoing financial commitments.
- **Sales (C3)**: The revenue generated from the sale of coal, which is crucial for assessing the financial viability of the investment.
- **Cost of Production (C4)**: The expenses directly related to the extraction and processing of coal, including labour, materials, energy, and equipment.
- **Profit (C5)**: The financial gain realized after accounting for all costs, serving as a key indicator of the project's success.
- **Discounted Cash Flow (C6)**: A valuation method that considers the present value of future cash flows, helping to evaluate the long-term profitability of the investment.
- **Net Present Value (NPV) (C7)**: A measure of the profitability of the project, calculated by subtracting the initial investment from the present value of expected cash flows over time. NPV is a critical factor in determining whether an investment will yield a positive return.
- **Net Cash Flow (C8)**: The difference between cash inflows and outflows, indicating the liquidity and financial health of the project over its lifecycle.

b. Data Collection:

The data collection process involves gathering both qualitative and quantitative information relevant to investment decision making in coal mining company. The sources of data include:

i. Quantitative data: Financial statements, investment proposals, project reports, and historical performance data provided by Mahanadi Coal Field Ltd for a period of five years.
ii. Qualitative data: The data collection process involves conducting discussions with experts from both the finance and project & planning departments of Mahanadi Coal Field Ltd. who are actively engaged in investment decision making. A total of 10 officials were approached, with insights and opinions collected from 8 individuals. The study is based on their expertise and experiences, as shared using the Saaty Scale of measure (Saaty, 1980).

c. **Research method:**

Based upon the quantitative data of 16 different projects of Mahanadi Coalfield Ltd. Collected with respect to different variables, based upon the qualitative discussion and expert opinions AHP has been used to evaluate the significance of these identified components and lastly the 16 alternative Investment opportunities has been ranked using TOPSIS, with regards to actual data and their weights as per AHP.

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP), a systematic decision-making technique was proposed by (Saaty, 1970) . AHP is the structured framework that prioritizes criteria, evaluates alternatives to reach at a rational and consistent decision. The first step in AHP involves constructing a hierarchical structure that breaks down the problem to a series of interrelated criteria and sub criteria. Thereafter opinions are collected from the decision-makers to have pairwise comparisons between the criteria at every level. Using a scale developed by Saaty, they assess the comparative significance of a attribute to others. The scale varies from 1 (equal importance) to 9 (extremely more important), with intermediate values representing intermediate degrees of preference. AHP ensures the consistency of pairwise comparisons by examining the consistency ratio (CR). If the CR exceeds a predefined threshold (usually 0.1), decision-makers are prompted to review and revise their judgments to improve consistency.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

(Hwang & Yoon, 1981) has proposed the TOPSIS as a decision-making tool. TOPSIS is widely cater as a tool to decision making by efficiently ranking the decision-alternatives with regard to their closeness to solution that been ideal to that particular scenario, considering multiple decision criteria. It evolves as a structured technique to decision-makers for assessment and prioritization of alternatives by quantifying their proximity to the ideal outcome. The first step in TOPSIS involves normalizing the decision matrix, which consists of alternatives and their performance on various criteria. Normalization standardizes the values of each criterion across alternatives to a common scale, typically between 0 and 1, making them comparable. Firstly, weights are assigned to each criterion by the decision-makers considering their competitive significance. These weights can be derived with tools like Analytic Hierarchy Process (AHP) or expert judgment as described earlier. TOPSIS defines two reference points: the solution that is ideal/ have a remarkable performance with regard to each identified criterion, and the anti-ideal solution, representing the worst performance. The ideal solution maximizes beneficial criteria and minimizes negative criteria, while the exact opposite been reflected in the anti-ideal solution. The Euclidean closeness among the potential alternatives and the best possible and worst possible solutions is calculated using TOPSIS. The Euclidean value measures the similarity or proximity of each alternative to the ideal and anti-ideal solutions in the multi-directional space defined by the decision criteria. TOPSIS computes the proximity of each substitute to the best possible solution by dividing the variance to the worst possible solution by the sum of the variance to the best and worst possible solutions. This ratio represents the relative closeness of each alternative. Alternatives with higher proximity values are considered more desirable and are ranked higher in the final ranking.

The present study offers a strategic approach to decision-making, blending the strengths of both AHP and TOPSIS, two well-established multi-criteria decision-making (MCDM) methods, to tackle the complexity of capital investment decisions in coal mining industry. The proposed strategy begins with the meticulous groundwork of identifying and prioritizing the criteria essential to investment decisions. This stage involves not just a mechanical assessment but a thoughtful synthesis of insights from a thorough literature review and a deep dive into budgets, ensuring that the decision-making process is rooted in both theoretical understanding and practical realities.

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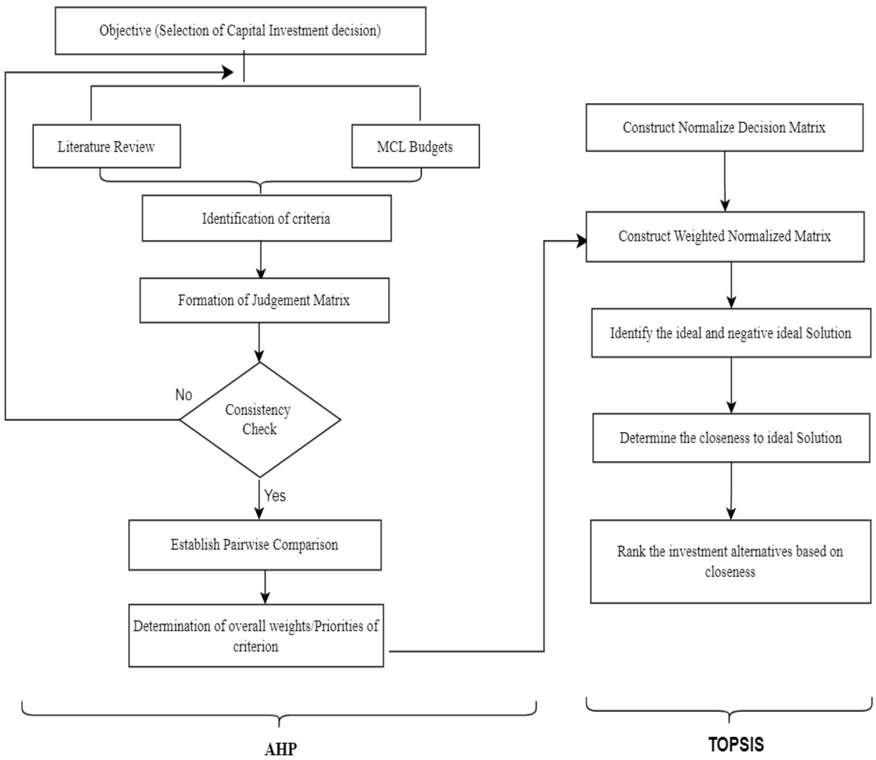
The AHP method serves as the foundation, where criteria are carefully compared and weighted against each other through a judgment matrix. This phase isn't just about numbers; it's about reflecting the nuanced priorities and strategic goals of MCL, ensuring that the final criteria weights truly represent the company's vision. The consistency check acts as a safeguard, ensuring that the judgments made are coherent and logical, reinforcing the reliability of the process.
Once the criteria are weighted, the focus shifts to the TOPSIS method, where these weights are applied to a normalized decision matrix. This is where the real-world alternatives are rigorously evaluated, not just in isolation but in comparison to an 'ideal' scenario. The beauty of TOPSIS lies in its ability to measure how closely each alternative aligns with the ideal solution, providing a clear, quantifiable ranking of options.

This integrated AHP-TOPSIS approach is not just a technical exercise; it's a reflection of a deliberate and comprehensive strategy to make well-rounded investment decisions. It considers both the inherent complexity of the factors involved and the need for a rational, structured approach to prioritizing investments in the highly dynamic environment of coal mining. The result is a decision-making framework that balances quantitative analysis with the strategic imperatives of MCL, guiding the company toward investment choices that are both economically sound and aligned with its long-term objectives. The diagrammatic flow of the proposed method has been illustrated in the figure 01;

Figure 01: Framework for AHP-TOPSIS based investment decision making system



6. Result and discussion (A case Study)

In evaluating the proposed comprehensive approach to investment decision-making, a detailed case study of Mahanadi Coalfields Limited (MCL), a subsidiary of Coal India Limited, has been undertaken. This case study focuses on identifying the variables that significantly contribute to the investment decision-making framework. These variables were derived from a thorough analysis of relevant literature and the budgets of MCL. To ensure the study's robustness, actual data from sixteen different capital investment decisions made by MCL, corresponding to each identified variable, have been considered. These variables were then subject to a structured evaluation process using the Analytic Hierarchy Process (AHP). The AHP methodology was employed to assign weights to each criterion, reflecting their relative importance in the decision-making framework. The assignment of weights was based on Saaty scale-based data, meticulously gathered from experts in the Finance and Project & Planning departments of MCL. This expert input was

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crucial in ensuring that the assigned weights accurately represented the practical realities and strategic priorities of MCL.

Table 4, as referenced, illustrates the pairwise comparison matrix used in the AHP process and the resulting weights assigned to each criterion, offering a transparent view of how each factor was evaluated and prioritized in the context of MCL's capital investment decisions. This case study not only validates the applicability of the proposed decision-making approach but also highlights its potential to guide more informed and strategically aligned investment decisions within the mining sector.

Table 4: Pairwise comparison matrix.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	Weights
C1	1	2.874102	2.446776	1.852959	1.036554	1.944202	0.9754	3.348995	0.201536
C2	0.3479347	1	1.722555	0.255226	0.601753	2.331947	0.389521	3.191825	0.097941
C3	0.408701	0.408701	1	0.444502	0.389521	2.728217	0.679183	3.918093	0.095049
C4	0.5396772	0.539677	2.249711	1	0.439641	3.734215	0.141214	2.728217	0.103481
C5	0.9647347	0.964735	2.567259	2.274582	1	3.918093	0.580533	2.693674	0.179053
C6	0.5143499	0.51435	0.36654	0.267794	0.255226	1	0.402596	0.332943	0.048001
C7	1.0252204	1.02522	1.472357	7.081469	1.722555	2.483882	1	3.734215	0.220337
C8	0.2985970	0.298597	0.255226	0.36654	0.37124	3.003515	0.267794	1	0.054603

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

Source: Author's own work

The Consistency Index (CI) for the Analytic Hierarchy Process (AHP) model in this study is calculated to be 0.080171, which is less than the threshold of 0.1, indicating that the judgments derived from the expert opinions are consistent and reliable. The assigned weights from the AHP analysis notably prioritize the Net Present Value (NPV, denoted as C7), highlighting its critical importance in the decision-making process for capital investments at MCL.

To comprehensively demonstrate the application of the proposed decision-making framework, a case study involving sixteen different investment alternatives at MCL was conducted. Using the weighted criteria derived from the AHP process, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) was then applied. This involved identifying both the ideal (best) and worst (negative ideal) solutions for each investment alternative, based on the weighted data and project information. The TOPSIS method calculates the distance of each investment alternative from these ideal and worst solutions, ultimately allowing for a ranking of the alternatives based on their proximity to the ideal solution.

The investment alternatives, labelled from I1 to I16, were ranked using the AHP-determined weights and the TOPSIS method, which was developed by Yoon and Hwang. The original investment decision data were normalized to form a decision matrix, with the normalized data then multiplied by the AHP weights to create a weighted normalized matrix, as shown in Table 5. Following the identification of the ideal and negative ideal solutions, the relative closeness of each investment alternative to the ideal solution was calculated, as presented in Table 8. This final ranking provided a clear hierarchy of the investment opportunities, highlighting the best investment option according to the proposed framework.

Table 5: Weighted Normalized matri

	C1	C2	C3	C4	C5	C6	C7	C8
I1	0.000266447	0.000701	9.06944E-05	0	3.24	0	0.051792	0
I2	0.000612804	0.001584	9.9426E-05	0.002482	2.50	0	0.203884	0
I3	0.1113249	0.007772	0.005525775	0.007256	10.09	0	0.000445	0.001662
I4	0.009243903	0.003467	0.005451631	0.001353	4.50	0	0.000172	0.019176

I5	0.008045994	0.001727	0.000687329	0.002232	2.29	0	0.059162	0
I6	0.016013519	0.001899	0.014340431	0.001982	-	0	0.001543	0
I7	0.022706052	0.003822	0.005054505	0.005994	6.12	0	0.02492	0.041677
I8	0.051270788	0.002087	0.000488912	0.006511	159.49	0	0.001377	0
I9	0.058225926	0.051826	0.004727742	0.024133	5.14	0.048001	0.003492	0
I10	0.090038163	0.01192	0.070261179	0.027497	17.90	0	0	0.022501
I11	0.114489988	0.046927	0.010040409	0.095975	57.40	0	0.001442	0.019176
I12	0.000137539	0.000151	3.88637E-06	0	-	0	0.012538	0
I13	0.001358317	0.000718	0	0.002862	1.85	0	0	0
I14	5.50668	0.003936	0.060656127	0	0.03	0	0	0
I15	0.00806578	0.066673	0.001774695	0.001555	32.56	0	0	0
I16	5.47339E-05	0.000116	0	0	0.96	0	0	0
V+	0.114489988	0.066673	0.070261179	0.095975	159.4907	0.048001	0.203884	0.041677
V-	5.47339	0.000116	0	0	0	0	0	0

Source: Author's own work

After identifying the positive ideal solution (V^+) and the negative ideal solution (V^-) which represent the maximum and minimum values in each column, respectively, as shown in Table 5 the next step in the TOPSIS methodology involves calculating the relative proximity of each investment alternative to the ideal solution. This relative proximity, also known as the closeness coefficient (CCI), is a measure of how close each investment option is to the ideal solution.

The CCI is calculated for each investment alternative, as illustrated in Table 6. This coefficient is determined by comparing the distance of each alternative to the positive ideal solution (V^+) and the negative ideal solution (V^-). The higher the CCI value, the closer the alternative is to the ideal solution, indicating a more favourable investment option. Based on these CCI values, the different investment alternatives of MCL represented as I1 to I16 are then ranked. This ranking reflects the relative desirability of each project, with those closest to the ideal solution being rated higher. The application of this method allows decision-makers to prioritize investment opportunities that align most closely with the optimal outcomes defined by the identified criteria, ensuring a more informed and strategic approach to capital allocation at MCL. hm

Table 6: CCI and Rank of Investment alternatives

Investment Alternatives	Si+	Si-	CCI	RANK
Unified Infrastructure (I1)	156.25	3.24	0.020323139	9
Resource Development (I2)	156.99	2.51	0.015713568	10
Safety (I3)	149.40	10.09	0.063278248	5
Material processing & Refinement (I4)	154.99	4.50	0.028220915	8
Surface operations (I5)	157.20	2.29	0.014375332	11
Transportation (I6)	159.49	0.02	0.000135885	15
Community Infrastructure (I7)	153.37	6.12	0.038353165	6
Sustainable Resource Management I8	0.26	159.49	0.998390712	1
Land (I9)	154.35	5.15	0.032263398	7
Mine Development (10)	141.59	17.90	0.112240463	4
R & D (I11)	102.09	57.40	0.359885614	2

Geospatial Information Insight (I12)	159.49	0.01	0.00006269	16
Innovation Amenities (I13)	157.64	1.85	0.011575775	12
Furniture & Fixture (I14)	159.46	0.07	0.000438445	14
Operational Amenities (I15)	126.93	32.56	0.204147898	3
asset development (I16)	158.54	0.96	0.005992089	13

Source: Author's own work

The above table indicates Sustainable Resource Management (I8) to be the most significant alternative with a highest CCI value of 0.99 and its closeness to Positive ideal solution with S+ value of 0.26 and distance from negative ideal solution with S- value of 159.49. Likewise, all other investment opportunities are ranked depending on the distance from ideal solution.

7. Findings:

The integrated analysis employing Analytic Hierarchy Process (AHP), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) highlights investment alternative I8 as the optimal choice. Subsequent to AHP weighting, based on expert opinions, prioritized Subsurface Net Present Value as crucial, the TOPSIS method then assessed investment alternatives' proximity to the ideal solution. Sustainable Resource management stands out as the most promising alternative, boasting a remarkably high CCI value, indicating its exceptional closeness to the positive ideal solution compared to others. This signifies its alignment with key criteria and objectives outlined in the analysis. Notably, the consistent alignment of the selected investment alternative with prioritized components and criteria underscores its robustness as an investment option. This comprehensive methodology ensures a rigorous and data-driven approach to investment decision-making, enhancing the likelihood of selecting options that best align with organizational objectives and stakeholder priorities.

8. Implication of the study:

The aim of this study is to suggest a comprehensive approach that will overcome the drawback associated to age-old investment decision making techniques that has still been used in coal mining companies' despite of today's complex decision-making scenario. The study will help the decision makers for taking a multi-factorial investment decision considering the most significant variables and for selection of highly efficient alternative out of the available investment opportunities by the use of suggested integrated AHP-TOPSIS approach. This will ensure alignment of investments with organizational objectives, maximum returns and overall efficiency.

9. Conclusion:

This study suggests moving toward a multi-criteria approach from conventional methods, in order to empower decision-makers to select investments that ensure the achievement of corporate objectives. The overall efficiency can be increased and returns can be maximized by implementing this thorough process. Additionally, the suggested strategy will support the success and long-term viability of coal mining operations. All things considered, this study stress upon how essential it is to have detailed and data-driven decision-making procedures in the complex scenario of coal mining investment. It offers a comprehensive framework to guide decision-makers to make wise investment decisions that fulfil the stakeholder interests and organizational goals.

References

1. Amiri, M. (2010). Application of fuzzy TOPSIS and AHP in the selection of the best alternative for oil company investment. Expert Systems with Applications, 37(9), 6218-6224.
2. Barda, O. H., Dupuis, J., & Lencioni, P. (1990). Multicriteria location of thermal power plants. European Journal of Operational Research, 45(3), 332-346.
3. Brennan, M. J., & Schwartz, E. S. (1984). *A new approach to evaluating natural resource investments*. Department of Accounting and Finance, Monash University.
4. Choudhary, D., & Shankar, R. (2012). A hybrid AHP-TOPSIS framework for the evaluation and selection of thermal power plant location: A case study from India. Energy, 42(1), 510-521.
5. Dixit, A. K., & Pindyck, R. S. (1994). *Investment under uncertainty*. Princeton university press.

6. Filipishyna, L., Mihai, N., Tarasov, I., Andriienko, M., & Arsawan, I. W. E. (2020). Management of the investment activities of the mining industry. *E3S Web of Conferences*, *201*. https://doi.org/10.1051/e3sconf/202020101015
7. Fountzoula, C., & Aravossis, K. (2021). Analytic hierarchy process and its applications in the public sector: a review. Academy of Accounting and Financial Studies Journal, 25(6), 1-15.
8. Ghasemzadeh, F., Archer, N. P., & Iyogun, P. (1999). Project portfolio selection through decision support. Decision Support Systems, 27(3), 329-342.
9. Hwang, C. L., Yoon, K., Hwang, C. L., & Yoon, K. (1981). Methods for multiple attribute decision making. *Multiple attribute decision making: methods and applications a state-of-the-art survey*, 58-191.
10. Mukherjee, K., & Bera, A. (1995). EUROPEAN JOURNAL OF OPERATIONAL RESEARCH Case Study Application of goal programming in project selection decision-A case study from the Indian Coal mining industry. In *European Journal of Operational Research* (Vol. 82).
11. Satty, T. L. (1970). Principle and appliance of analytic hierarchy process. *Management Science*, *11*.
12. Setiyawan, H., & Ciptomulyono, U. (2021). A Combined AHP-GP for Maintenance Project Selection in Coal Power Plant. *IPTEK Journal of Proceedings Series*, (3), 307-313.
13. Smit, H. T., & Ankum, L. A. (1993). A real options and game-theoretic approach to corporate investment strategy under competition. *Financial Management*, 241-250.
14. Trigeorgis, L. (1993). Real options and interactions with financial flexibility. *Financial management*, 202-224.
15. Valadan Zoej, M. J., Mesgri, M. S., Beheshtifar, S., & Karimi, M. (2013). Thermal power plant site selection using GIS. Retrieved from http://www.gisdevelopment.net/application/utility/power/ma05154.htm
16. Zhou, P., Ang, B. W., & Poh, K. L. (2006). Decision analysis in energy and environmental modeling: an update. Energy, 31(4), 2604-2622.