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Optimizing Post-Mining Land Use by Weighted Sum Method Decision Making Analysis

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ABSTRACT

This study evaluates five prominent Wireless Power Transfer (WPT) technologies Inductive Coupling, Resonant Inductive Coupling, Radio Frequency (RF) Transfer, Magnetic Resonance Coupling, and Laser Power Transfer based on multiple performance criteria using the Grey Relational Analysis (GRA) method. The technologies were assessed on four key parameters: efficiency, range, safety, and cost-effectiveness. Through normalization, deviation sequence, and the calculation of Grey Relational Coefficients (GRC), we established a Grey Relational Grade (GRG) for each technology, ranking them based on their overall performance. The results show that Laser Power Transfer ranks highest among the WPT methods, achieving the best balance of range, safety, and cost-effectiveness, with a GRG of 0.8571. This technology is optimal for applications requiring long-range power transfer, although it has moderate efficiency. Inductive Coupling, with the second-highest GRG (0.5238), excels in efficiency but is limited by its short range, making it ideal for close-contact applications, such as charging pads. RF Transfer ranks third, offering a moderate balance of range and cost-effectiveness, suited for remote, low-power applications where efficiency is less critical. Magnetic Resonance and Resonant Inductive Coupling rank fourth and fifth, respectively, showing moderate performance across all criteria without excelling in any specific aspect. The use of GRA enables a structured and quantitative assessment of each technology's suitability for various applications, highlighting their strengths and limitations relative to an ideal performance profile. This research provides valuable insights for selecting WPT technologies based on specific operational requirements, supporting decision-making in fields such as consumer electronics, medical devices, and industrial automation. Future work may involve exploring other criteria, such as environmental impact and scalability, to further refine the selection process.

1. INTRODUCTION

Reclamation of land and related post-mining operations are critical components of any mining project. Identifying the most appropriate land uses for the restored mining area is a crucial part of the entire process. However, choosing the optimal land use is a challenging task that involves "multiple criteria and factors (including geotechnical, environmental, legal, economic, and social aspects)". Additionally, it is essential to ensure that the local community approves of the reclamation plan. The problem's complexity is exacerbated by the nature of social and environmental restrictions, as well as the subjectivity that characterizes decision makers such as municipal administrations or local communities. Numerous research papers have been released regarding land reclamation and the strategic planning of land utilization in the mining sector. Most of these studies focus on evaluating and prioritizing various potential land uses, with the aim of ultimately selecting a single land

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use for the entire mined area. This selection process is facilitated by employing "multicriteria decision-making (MCDM) methodologies". The creation for the analytical hierarchy procedure (AHP) tool, which analyses priorities based on input from mining sector professionals, exemplifies the MCDM approach.AHP manages the qualitative including quantitative requirements associated with reclamation issues, allowing the selection team to thoroughly study, compare, and prioritise the relevant criteria as well as sub- criteria. The advantages of stakeholder participation participation include successful project execution, political acceptability, and proper regulatory enforcement, trust and assurance building, increasing awareness, giving information, and providing a choice development, and economic efficiency. To make well-grounded decisions in which conficts and conflicts between stakeholders' viewpoints are eliminated by participation in Decision-makers should use ways that embrace a varied variety of opinions, values, and facts to ensure a visible, traceable, and well-structured decision-making process. Our culture and civilisation are now heavily dependant on the mining sector in order to make it remain comfortable. Mining, on the reverse hand, is a temporary land use that turns fertile agricultural area into wasteland and produces large volumes of waste. Solid waste accumulates on the outermost layer and take up a lot of area. In accordance with Li (2006), a mine-degraded wilderness commonly comprises of "striped regions (59%), mines with open pits (20%), tailings' dams (13%), rubbish points (5%), and mining subsidence-affected land (3%)".The key difficulty is choosing the appropriate use use "post-mining land following the closure of the mine or through the mining process" to accomplish the dual aim of exploiting mines as well as their products while reducing the negative environmental effects of mining activities.

2. MATERIALS AND METHODS

Conformity with government policy: Weights are commonly regarded as "general markers of the relative importance for each objective function". However, because personal preferences are frequently vague, selecting a collection of weights which demonstrates preference for a specific aim over another possibilities is difficult.[8] Furthermore, even with a thorough understanding of the targets and an appropriate weight selection. "The final result may not necessarily reflect the expectations that appear to be represented in the weights". However, since the weights used define "the specific Pareto maximum point that is offered as a solution, understanding how the weights connect to habits, the parameters of the Pareto ideally set, and how the specific objective functions" is critical. [9]

Maintenance cost: We present in this study a specialised procedure for identifying numerous uncommon mutations driving an illness that is genetically diverse. Real-world information and electrical simulations demonstrate that the proposed weighted-sum method works. outperforms previous methods [10]. This highlights how the application of specific analytical approaches can increase the ability to determine the genetic components of complex (genetically heterogeneous) illnesses. "Keep in mind, however, that the strength of such specialisation comes at the sacrifice of generality, thus the strategies must be employed in tandem alongside other tactics addressing diverse biological circumstances, such as the common variation common illness scenario".[11]

Flexibility with local lifestyle: The design's purpose optimization is to find the optimum design that minimises the objective function while satisfying design limitations. Several design criteria or objective functions must frequently be considered concurrently during design optimisation. For example, when designing an aero plane, we may wish to Maximized distance and package mass while lowering lifetime costs When more than one design objective is associated, "the design problem becomes multiobjective, and the standard design optimisation for a scalar objective function is no longer applicable".[12]

Payback period: Most population-based search processes, such as evolutionary, particle swarm, or ant colony optimisation, require one characteristic value known as fitness. This could explain why a number of optimization parameters are typically merged into a single quality grade.[13] The weighted sum strategy and the -constrained methodology are introduced briefly. Another popular method is to express things in terms of costs. A closer examination reveals that such is the calculated sum technique with adequate optimisation. Furthermore, shifting to expenses necessitates a fictitious rethink of the underlying aims. which is typically ineffective. As a result, at least in academia, most multi-objective optimisation problems have been solved using Pareto. [13]

Improving the life quality: Depth estimate is an essential intermediary step towards 3D environment reconstruction and comprehension since it attempts to anticipate pixel-wise thickness for a single or several images. Depth information has been shown to aid in activities such as recognition, communication between humans and computers, and three-dimensional model reconstruction. Traditional depth prediction methodologies, such as N-view the rebuilding process, structure following motion (SFM), and simultaneous mapping and localization (SLAM), have generally relied on a large number of images. [14]

Operating cost: "Power/rate control, link time management, cross-layer management, network utility maximisation, beams shaper development for multiple-input multiple-output relationships, and many other modern resource management difficulties" are handled directly or indirectly. The issue of cumulative sum-rate optimisation (WSR Max) is used. [15] In general, this problem is extremely complex to resolve and is NP-hard. We provide a comprehensive explanation of the present WSR Max issue resolution methodologies, including global, rapid local, and decentralised solutions, in this paper. We also discuss how to create WSR Max algorithms using generic optimisation approaches like as branch and constraint procedures, homotopy techniques complementing mathematical computer science, primal deconstruction methods, sub gradient techniques and sequential approximation strategies [16].

Maintenance cost: We used a lightweight transportable vibrator to assess the preciseness of the 'weighted summing' technique of estimating ground force. Investigations with an elastically suspended vibrator indicated that, contrary to traditional theory assumptions, the magnitude of the sum of the weighted ground force at elevated frequencies (> -500 Hz) was substantially more than zero. Similar results were obtained in several tests using load cells. These differences, if not adjusted for, can result in significant 'vibroseis correlations noise' in processing records [17].

Weighted sum method: In the oil sector, vibrational sources are commonly utilised in earthquake reflection examinations. They have also gained significance in shallower (up to 300 m) geophysical applications in the last decade "(Nijhof 1992; Doll with Miller 1996; Buness et al. 1997)".In terms of having the capacity to tune earthquakes waveform resolution, vibrators offer a significant advantage over regular impulsive sources (Pritchett 1994; Brouwer et al. 1997) [18].

3. RESULT AND DISCUSSION

TABLE 1. The determination of the best post-mining land usage

	Conformity with government policy	Maintenance cost	Flexibility with local lifestyle	Payback period	Improving the life quality	Operating cost	Maintenance cost
Solar power station	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Pit backfilling	1.2	4.0	6.2	1.6	2.9	6.0	7.6
Educational centers	7.3	2.7	2.2	8.6	7.9	8.1	6.6
Industrial construction	7.4	5.4	4.0	2.1	7.1	2.1	2.1
Revegetation	4.2	2.1	9.0	3.7	3.0	4.7	5.6
Agriculture	7.1	3.1	1.4	8.5	7.0	1.8	2.0

Table 1 shows the analytical technique in WSM alternative is used to determine the ideal post-mining land use. Projects include solar power plants, pit backfilling, educational institutions, industrial buildings, and reforestation agriculture. Compliance with government policies is assessed. The cost of upkeep, Flexibility in terms of local lifestyle, Repayment term, raising living standards Expenses for operations and maintenance.

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Table 2 shows the analytical technique in WSM alternative is used to determine the ideal post-mining land use. Projects

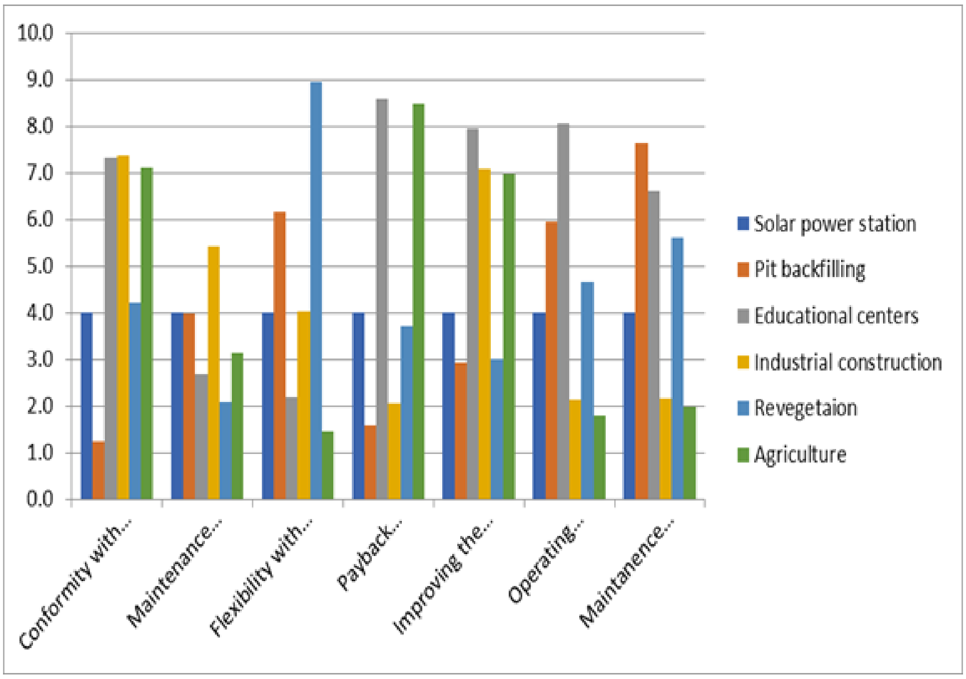

FIGURE 1. The selection of optimal post- mining land use

TABLE 2. Normalized data

	Conformity with government policy	Maintenance cost	Flexibility with local lifestyle	Payback period	Improving the life quality	Operating cost	Maintenance cost
Solar power station	0.54213	0.73568	0.44579	0.46572	0.50245	0.44822	0.49302
Pit backfilling	0.16950	0.73426	0.68857	0.18386	0.36968	0.30035	0.25788
Educational centers	0.99586	0.49615	0.24426	1.00000	1.00000	0.22209	0.29727
Industrial construction	1.00000	1.00000	0.45137	0.24093	0.89143	0.84162	0.91567
Revegetation	0.57318	0.38258	1.00000	0.43428	0.37868	0.38404	0.35092
Agriculture	0.96514	0.57640	0.16094	0.98934	0.87966	1.00000	1.00000

include solar power plants, pit backfilling, educational institutions, industrial buildings, and reforestation agriculture. Compliance with government policies is assessed.The cost of upkeep, Flexibility in terms of local lifestyle, Repayment term, raising living standards Expenses for operations and maintenance.

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Table 3 shows the optimal post-mining land use is determined utilising the analytical approach in WSM alternative. Solar power plants, pit backfilling, educational facilities, industrial building, and reforestation agriculture are all examples of projects. Evaluation adherence to government policy .The expense of maintenance, Flexibility with regard to local lifestyle, Repayment period, improving the standard of living, Operating and maintenance expenses.

Figure **??** shows the optimal post-mining land use is determined utilising the analytical approach in WSM alternative. Solar power plants, pit backfilling, educational facilities, industrial building, and reforestation agriculture are all examples of projects. Evaluation adherence to government policy .The expense of maintenance, Flexibility with regard to local lifestyle, Repayment period, improving the standard of living, Operating and maintenance expenses.

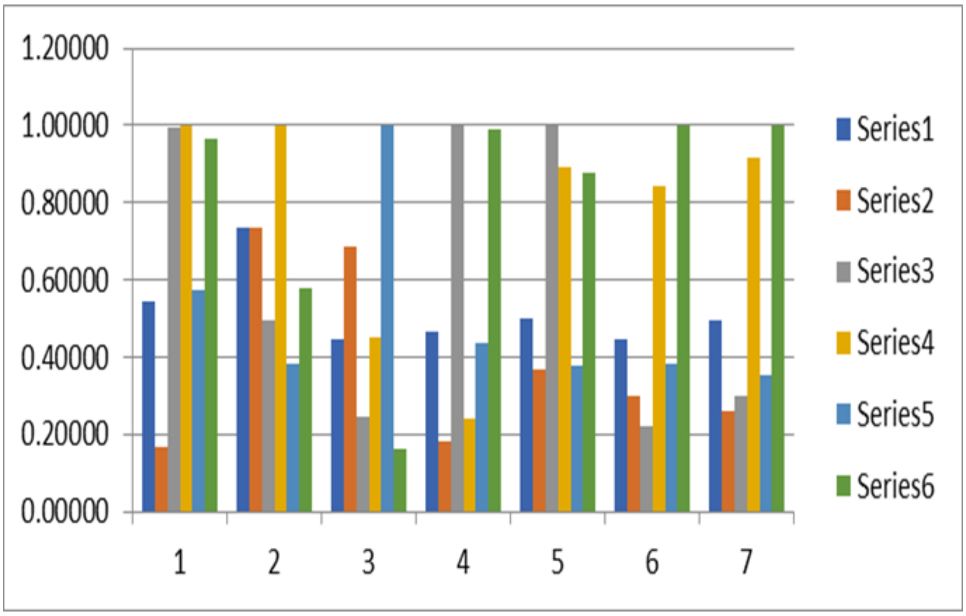

FIGURE 2. Normalized data

TABLE 3. Weighted normalized data

	Conformity with government policy	Maintenance cost	Flexibility with local lifestyle	Payback period	Improving the life quality	Operating cost	Maintenance cost
Solar power station	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Pit backfilling	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Educational centers	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Industrial construction	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Revegetation	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Agriculture	0.14	0.14	0.14	0.14	0.14	0.14	0.14

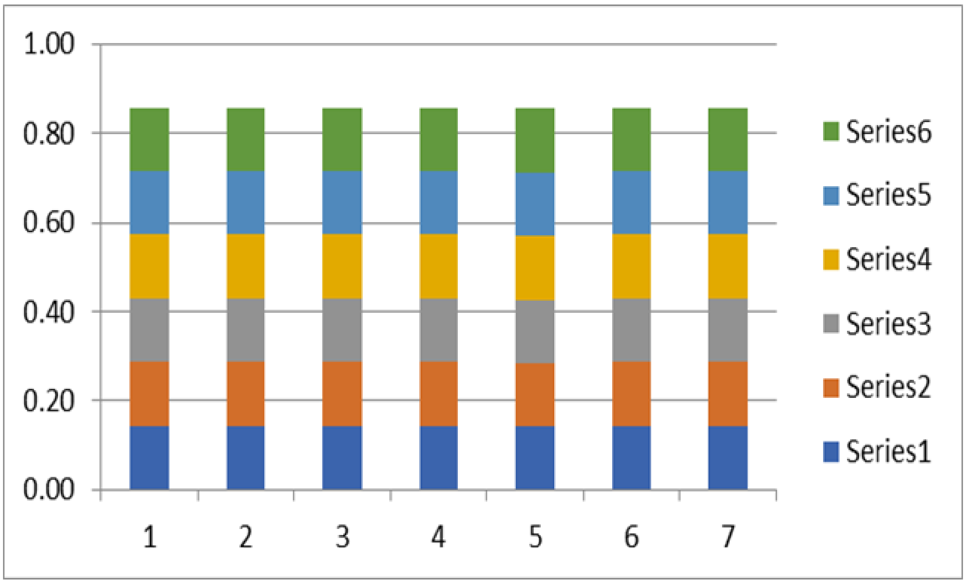

FIGURE 3. Weighted normalized data

TABLE 4. Preference

	preference
Solar power station	0.51900
Pit backfilling	0.38524
Educational centers	0.60795
Industrial construction	0.76300
Revegetaion	0.50053
Agriculture	0.79593

Table **??** indicating preference of of the selection of appropriate post- mining land use, utilising the analysis approach in WSM replacement Solar generating station, Pit backfilling, Instructional centres, Commercial construction, Revegetaion Agriculture.

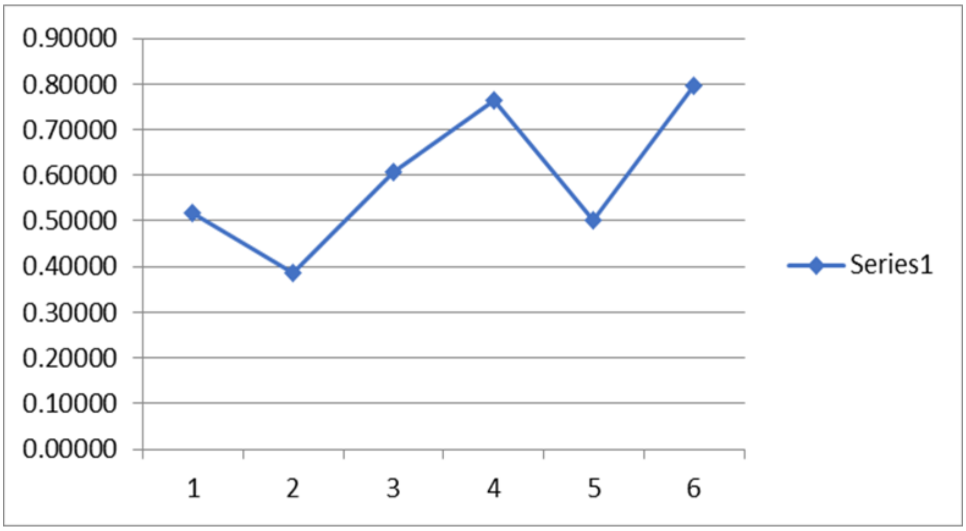

FIGURE 4. Preference

Figure 4 indicating preference of of the selection of appropriate post- mining land use, utilising the analysis approach in WSM replacement Solar generating station, Pit backfilling, Instructional centres, Commercial construction, Revegetaion Agriculture.

TABLE 5. Rank

	preference
Solar power station	4
Pit backfilling	6
Educational centers	3
Industrial construction	2
Revegetaion	5
Agriculture	1

Table 5 indicates rank of the selection of appropriate post- mining land use, utilising the analysis approach in WSM replacement Solar generating station, Pit backfilling, Instructional centres, Commercial construction, Revegetation Agriculture.

Figure 5 indicates rank of the selection of appropriate post- mining land use, utilising the analysis approach in WSM replacement Solar generating station, Pit backfilling, Instructional centres, Commercial construction, Revegetation Agriculture.

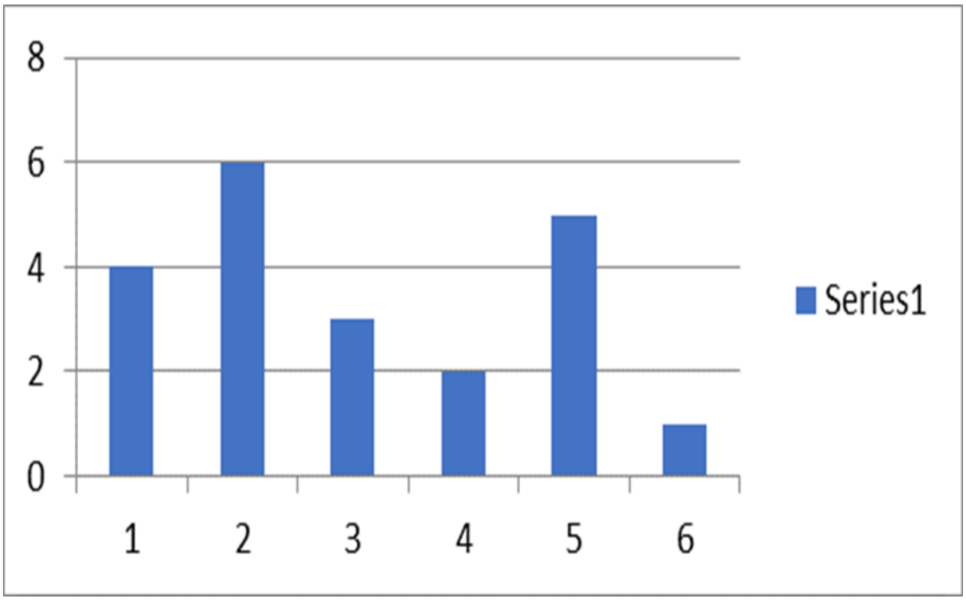

FIGURE 5. Rank

4. CONCLUSION

A combination of two fuzzy MADM techniques was used to rank as well as determine the post-mining land-use. The FAHP method was used to calculate the significant scores of characteristics, and the FTOPSIS methodology was utilised to determine the order of the options. Because of the ambiguity of the topic, fuzzy theory can assist specialists in making better conclusions. In this work, 52 attributes were used to think about all of the aspects that influence the recovered land restoration method of choice. Based on the place of operation, conditions, and size of each mine, all of these variables have an impact. Other factors, however, have a greater influence on the decision regarding post-mining land-use. This technique looks to be favourable in economic, technological, environmental, and social aspects, according to the study's conclusions. In order to minimise costs and enhance advantages resulting from an economic aspect, it is also necessary to reduce mining's environmental impact, establish social trust in the mining industry, and assess the process from a technical standpoint.

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