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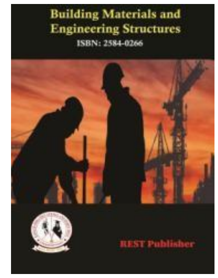

Hybrid BWM-VIKOR Method for Optimal Site Selection

Chinnasami Sivaji, Sathiyaraj Chinnasamy, M. Ramachandran, Vidhya Prasanth

REST Labs, Kaveripattinam, Krishnagiri, Tamil Nadu, India

*Corresponding Author Email: chinnasamirsri01@gmail.com

Abstract: *This research article presents an innovative hybrid approach prioritize potential site layout options for the Mehr Construction Project in Tehran, Iran, taking into consideration economic and safety factors. The authors identify various specifications for selecting suitable locations, drawing from existing literature. Moreover, they apply expert judgment to select the most viable options that align with the current conditions in Tehran. The appropriate site plan sites are then established as viable possibilities and ranked by specialists depending on the structure. The study employs the surveys are utilized for this purpose. The final ranking of the site options is then achieved by combining the Grey Relational Analysis (GRA) and VIKOR methodologies. Interestingly, the computational results indicate that both the VIKOR and GRA approaches yield the same rating. To enhance the reliability of determining the best possible building site plan, a more robust approach is recommended. Consequently, sensitivity analysis is conducted on the final outputs, considering the parameters used in the VIKOR and GRA approaches. This analysis enables the ranking of options and facilitates the selection of the optimal strategy. Decision-making procedures have grown increasingly difficult in today's complicated and changing corporate world. Organizations require rigorous and efficient ways for efficiently evaluating and prioritizing alternatives. The approach that allows decision-makers to analyses options based on many criteria. AHP, on the other hand, has limits, especially when dealing with imprecise or ambiguous data. Researchers have developed a hybrid technique that leverages the capabilities of different decision-making systems to address these constraints. A hybrid technique method is one such example. The hybrid technique has major scientific relevance in numerous disciplines. Overall, the hybrid BWM-VIKOR method helps with procedures for making choices, multi-criteria decision inspection, environmentally conscious development, supplier selection, together with project management. Its relevance a systematic and complete technique for addressing complex choice issues across several domains, eventually leading to better informed and optimum decision-making results. In this research we will be using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Alternative Parameters taken as Safety Flexibility of Equipment, Light Shortage, Respiratory Risks, Access to Standard Equipment, Protective Equipment for Labor, Materials Safety Information and Guidelines, The Relationship Between Labor and Equipment. From the result we get to know that Safety Flexibility of Equipment got the lowest rank were as Respiratory Risks got highest rank. From the above results I conclude that Respiratory Risks got highest rank compared to others.*

Keywords: *Safety Flexibility of Equipment, Light Shortage, Respiratory Risks, Access to Standard Equipment, Protective Equipment for Labor.*

1. INTRODUCTION

In certain applications, particularly in civil projects undertaken by government or private sectors, significant expenditures are allocated to ensure safety and appropriate facility layout. Consequently, the primary objective in such scenarios is to minimize system costs while maximizing safety levels (Kumar & Cheng, 2015; Said & El-Rayes, 2013). While many studies have focused on cost minimization alone, real-world managers often aim to optimize multiple objectives, including maximizing safety levels [1]. Modifying a facility layout after project implementation is challenging or even impossible. Therefore, it becomes crucial to assess all factors that influence decision-making comprehensively (Yahiya & Saka, 2014). Furthermore, safety plays a vital role in industrial and construction projects, and various elements impact its level and effectiveness. This is a critical concern since compromised worker, management, and equipment safety may result in costly postponements and fines. When workers' safety is jeopardized, large private or state penalties are imposed (Keven et al., 2018). As a result, an appropriate model for good facility layout in building projects should be suggested by taking into account all of the beneficial variables [2]. A thorough model based on MCDM approaches and a simulation tool is described contribute to addressing Iran's energy challenges by determining the optimal areas for solar site development. Numerous provinces in Iran, including South Khorasan, possess substantial potential for generating solar power (Alamdari et al., 2013). To achieve this goal, the researchers gather the most pertinent criteria and sub-criteria for identifying suitable solar sites from existing research. These criteria are then adjusted based on expert opinions and considering the specific environmental conditions of the province. By combining these factors, the model aims to provide a comprehensive and tailored assessment for selecting the most [3]. (OHS) perspective. The primary objective of ORA is to determine whether the identified potential (Kabakulak, 2019). While the primary focus of ORA is to protect employees, it also takes into account secondary goals such as operational safety and production. This means that in addition to ensuring the well-being of workers, ORA considers the impact on productivity and operational efficiency. By addressing both primary and secondary goals, ORA aims to strike a balance between worker safety and the smooth functioning of business operations. In the evaluation and selection processes, proposed by Aikhuele (2019), was employed to assess and choose the designs. In a study conducted by Mytilinou et al. (2018), construction location criteria were evaluated using a combination of quality, cost, and safety strategies in building projects, utilizing the TOPSIS technique. assistance to project managers in achieving success. Based on the aforementioned process, the following sub-criteria were identified from previous cases: project type, safety, software development, project duration, and building dimensions. [9].

2. MATERIALS AND METHOD

Their similarities to an ideal solution. It is a well-known method that helps decision-makers evaluate and rank alternatives by considering multiple criteria. best choice from a group of alternatives. Hwang and Yoon initially developed it in 1981, and it has since become extensively used in a variety of sectors, including business, engineering, together with social sciences. The TOPSIS technique seeks to rank options thereby reflecting the greatest possible conclusion. It considers a number of factors or qualities that are significant for decision-making. whichever is closest to the nature of the problem, these criteria might be quantitative or qualitative.

Safety Flexibility of Equipment: The BWM-VIKOR (Best Worst technique-VIKOR) technique combines the Rexene) decision-making strategy. It is used for evaluating and categorizing alternatives based on a variety of factors. When examining the safety flexibility concerning equipment using called BWM-VIKOR technique, various parameters that contribute to these qualities are often considered.
Light Shortage: A light deficit can also be caused by issues with the wiring in the car. This might involve problems with the vehicle's wiring, connections, fuses, relays, or batteries. To detect and repair such issues, a competent mechanic or electrician must conduct a complete check.
Respiratory Risks: The BWM-VIKOR hybrid approach (Best-Worst technique and VIKOR) has become a framework for making decisions that combines is most commonly employed to solve decision-making difficulties, it may not be immediately applicable to analyzing respiratory hazards. Respiratory risks often entail assessing several aspects of respiratory health, which include pollution exposure, occupational hazards, in addition to disease prevalence. To evaluate respiratory hazards, you would normally use methodologies and instruments established expressly for risk assessment surrounding the field concerning respiratory health.
Access to Standard Equipment: The term "standard equipment" am able to refer to the standard or default collection of tools, gadgets, or resources whose services are usually offered or utilized in a certain environment. The particular standard equipment might differ contingent upon the industry, field, in addition to activity under consideration. It should be noted, however, that they particular norms for equipment might differ based on the setting and sector**.**
Protective Equipment for Labor: Protective equipment for labor (PPE) refers to specialized clothes, gear, or technologies meant to shield employees from possible risks and assure their safety in a variety of work conditions. The type of PPE necessary will be determined by the nature concerning the task and the dangers involved. Protective equipment for labour (PPE) refers to specialized clothes, gear, or technologies meant to shield employees from possible risks and assure their safety in a variety of work conditions. The type of PPE necessary will be determined by the requirements of the task and the dangers involved.

Materials Safety Information and Guidelines: Materials Safety Information in addition to Guidelines are critical papers that give vital information and directions on ensuring the secure handling, storage, use, particularly the elimination of various materials. Chemicals, toxic compounds, agents of biology, radioactive materials, and a variety of materials are examples of these materials. The goal of these rules is to safeguard people's health and safety, to protect the environment, especially to prevent accidents or situations that might cause harm. Materials Safety Information Especially Guidelines may differ based on the individual material and legal requirements in various nations or locations. For the sake of accurate and up-to-date information, it is critical to examine and follow the precise instructions offered by manufacturers, regulatory authorities, or reputable sources.
The Relationship Between Labor and Equipment: The connection and interdependence between staff members in addition to the tools, machines, and technology they utilise in the manufacturing process is referred to as the labor-equipment relationship. Labour and equipment are critical production elements in many sectors, and they play critical roles with respect to productivity and efficiency. To maximise output, protect worker safety, and react to evolving technological breakthroughs, it is critical to create a balance between labour and equipment. Depending on factors for example the nature of the task, available technology, in addition to economic concerns, any particular connection between labour and equipment might vary among sectors and individual firms.

3. RESULT AND DISCUSSION

TABLE 1. data Set

	DATA SET				
	R(1)	R(2)	R(3)	R(4)	R(5)
Safety flexibility of equipment	0.256	0.072	0.103	0.106	0.253
Light shortage	0.099	0.139	0.256	0.097	0.104
Respiratory risks	0.033	0.096	0.077	0.034	0.028
Access to standard equipment	0.107	0.249	0.103	0.251	0.099
Protective equipment for labor	0.074	0.139	0.103	0.072	0.149
Materials safety information and guidelines	0.149	0.105	0.103	0.145	0.133
The relationship between labor and equipment	0.099	0.033	0.154	0.141	0.099

This table shows TOPSIS Method. Here in this table R(1), R(2), R(3), R(4), R(5). evaluation preferences: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment.

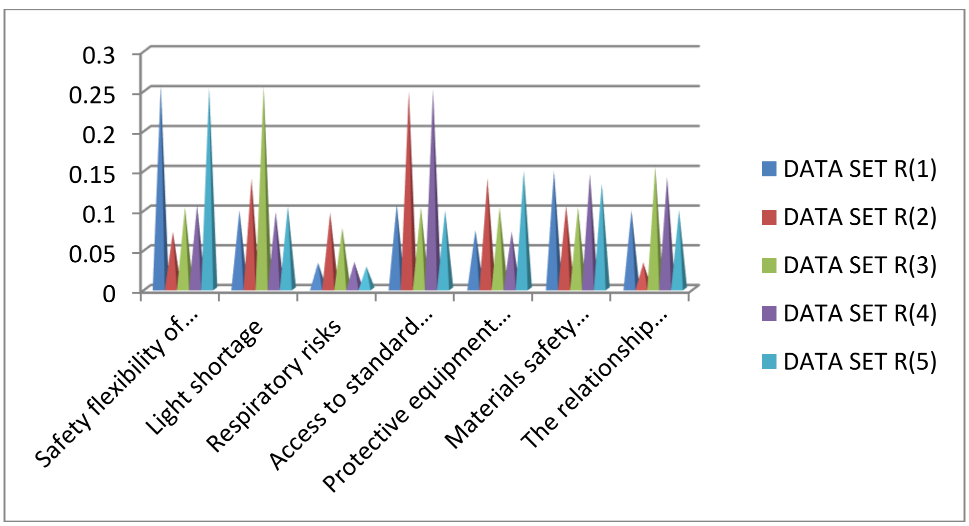

FIGURE 1. Data Set

This Figure shows TOPSIS Method. Here in this table R(1), R(2), R(3), R(4), R(5).evaluation preferences: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment.

TABLE 2. Squire Rote of matrix

	R(1)	R(2)	R(3)	R(4)	R(5)
Safety flexibility of equipment	0.0655	0.0052	0.0106	0.0112	0.0640
Light shortage	0.0098	0.0193	0.0655	0.0094	0.0108
Respiratory risks	0.0011	0.0092	0.0059	0.0012	0.0008
Access to standard equipment	0.0114	0.0620	0.0106	0.0630	0.0098
Protective equipment for labor	0.0055	0.0193	0.0106	0.0052	0.0222
Materials safety information and guidelines	0.0222	0.0110	0.0106	0.0210	0.0177
The relationship between labor and equipment	0.0098	0.0011	0.0237	0.0199	0.0098

This table shows TOPSIS Method. Here in this table R alternative: R(1), R(2), R(3), R(4), R(5). evaluation preferences: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment.

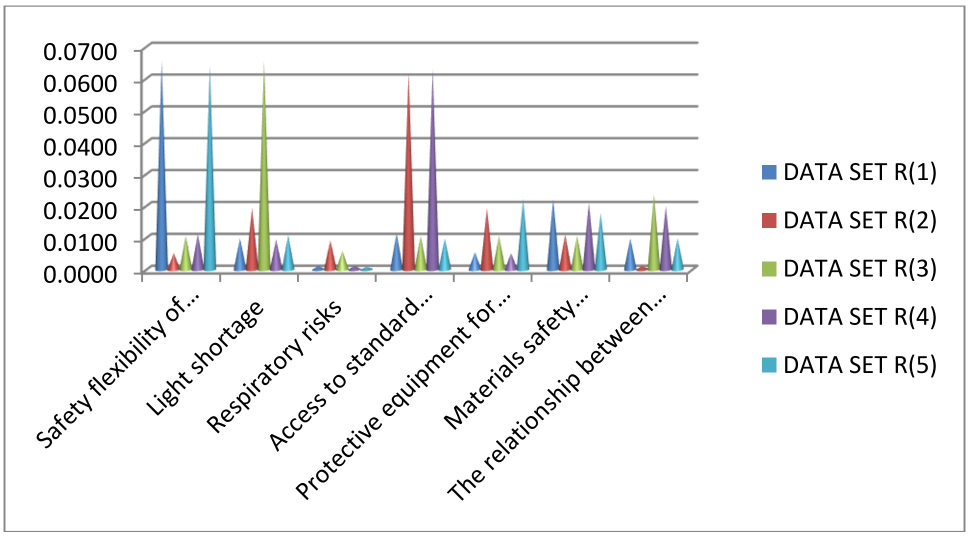

FIGURE 2. Squire Rote of matrix

This Figure shows TOPSIS Method. Here in this table R alternative: R(1), R(2), R(3), R(4), R(5). evaluation preferences: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment.

TABLE 3. Normalized Data

	Normalized Data				
Safety flexibility of equipment	0.7231	0.2034	0.2909	0.2994	0.7146
Light shortage	0.2796	0.3926	0.7231	0.2740	0.2937
Respiratory risks	0.0932	0.2711	0.2175	0.0960	0.0791
Access to standard equipment	0.3022	0.7033	0.2909	0.7089	0.2796
Protective equipment for labor	0.2090	0.3926	0.2909	0.2034	0.4208
Materials safety information and guidelines	0.4208	0.2966	0.2909	0.4095	0.3757
The relationship between labor and equipment	0.2796	0.0932	0.4350	0.3982	0.2796

This table shows TOPSIS method of Normalized Data. Table 3 shows the normalized data for the Circular Economy alternatives using the TOPSIS method. The data has been normalized to bring all the criteria to the same scale, which is a value between 0 and 1. The normalization has been performed by dividing each criterion's value by the maximum value of that criterion across all alternatives. For example, in the first row of the table, the maximum value for Reliability across all alternatives is 96.33. Therefore, the Reliability score for the "Regenerate" alternative (which is 82.08) has been divided by 96.33, resulting in the normalized score of 0.3812. This process has been repeated for all the criteria and alternatives. The resulting table shows the normalized scores for each alternative on each criterion, which can be used to calculate the weighted normalized score for each alternative in the next step of the TOPSIS method.

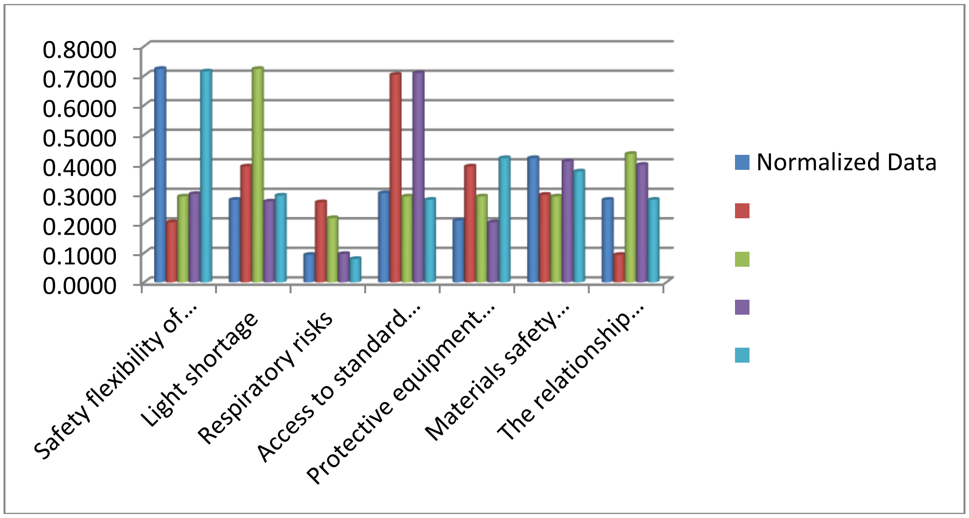

FIGURE 3. Normalized Data

This table shows TOPSIS method of Normalized Data. Table 3 shows the normalized data for the Circular Economy alternatives using the TOPSIS method. The data has been normalized to bring all the criteria to the same scale, which is a value between 0 and 1. The normalization has been performed by dividing each criterion's value by the maximum value of that criterion across all alternatives.

TABLE 4. Weighted normalized decision matrix

Weighted normalized decision matrix					
Safety flexibility of equipment	0.1808	0.0508	0.0727	0.0748	0.1786
Light shortage	0.0699	0.0981	0.1808	0.0685	0.0734
Respiratory risks	0.0233	0.0678	0.0544	0.0240	0.0198
Access to standard equipment	0.0756	0.1758	0.0727	0.1772	0.0699
Protective equipment for labor	0.0523	0.0981	0.0727	0.0508	0.1052
Materials safety information and guidelines	0.1052	0.0741	0.0727	0.1024	0.0939
The relationship between labor and equipment	0.0699	0.0233	0.1087	0.0996	0.0699

This table shows TOPSIS method of Weighted normalized decision matrix. Table 4 shows weighted normalized decision matrix for Alternative: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment,

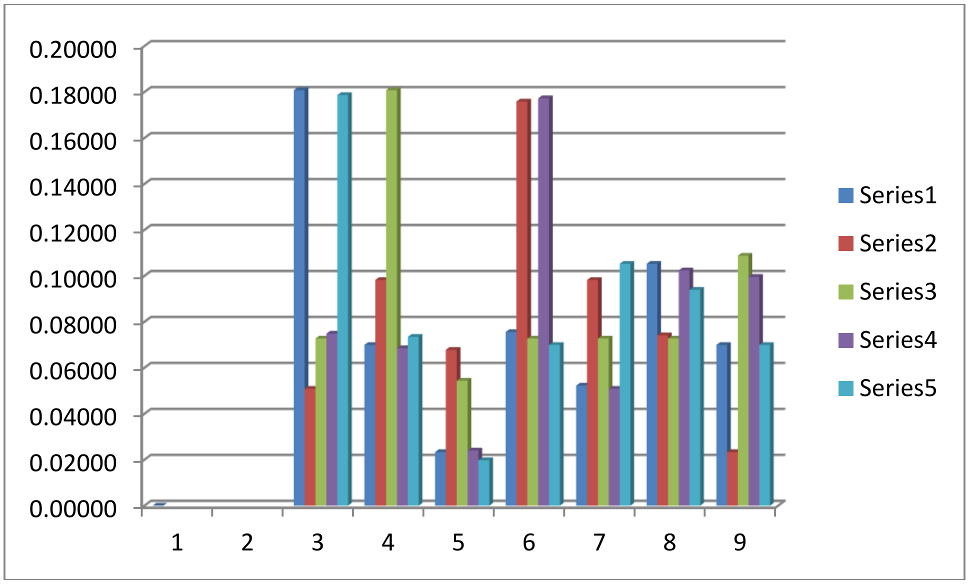

FIGURE. 4 Weighted normalized decision matrix

This Figure shows TOPSIS method of Weighted normalized decision matrix. Table 4 shows weighted normalized decision matrix for Alternative: Safety flexibility of equipment, Light shortage, Respiratory risks, Access to standard equipment, Protective equipment for labor, Materials safety information and guidelines, The relationship between labor and equipment.

TABLE 5. Positive Matrix

	Positive Matrix				
Safety flexibility of equipment	0.1808	0.1808	0.1808	0.1808	0.1808
Light shortage	0.1808	0.1808	0.1808	0.1808	0.1808
Respiratory risks	0.1808	0.1808	0.1808	0.1808	0.1808
Access to standard equipment	0.1808	0.1808	0.1808	0.1808	0.1808
Protective equipment for labor	0.1808	0.1808	0.1808	0.1808	0.1808
Materials safety information and guidelines	0.1808	0.1808	0.1808	0.1808	0.1808
The relationship between labor and equipment	0.1808	0.1808	0.1808	0.1808	0.1808

This table shows TOPSIS method of Positive Matrix.

TABLE 6. Negative matrix

	Negative matrix				
Safety flexibility of equipment	0.0233	0.0233	0.0233	0.0233	0.0233
Light shortage	0.0233	0.0233	0.0233	0.0233	0.0233
Respiratory risks	0.0233	0.0233	0.0233	0.0233	0.0233
Access to standard equipment	0.0233	0.0233	0.0233	0.0233	0.0233
Protective equipment for labor	0.0233	0.0233	0.0233	0.0233	0.0233
Materials safety information and guidelines	0.0233	0.0233	0.0233	0.0233	0.0233
The relationship between labor and equipment	0.0233	0.0233	0.0233	0.0233	0.0233

This table shows TOPSIS method of Negative Matrix.

TABLE 7. SI Plus

	SI Plus
Safety flexibility of equipment	0.1513
Light shortage	0.1908
Respiratory risks	0.3021
Access to standard equipment	0.1872
Protective equipment for labor	0.2253
Materials safety information and guidelines	0.1763
The relationship between labor and equipment	0.1907

This table shows TOPSIS method of SI Plus.

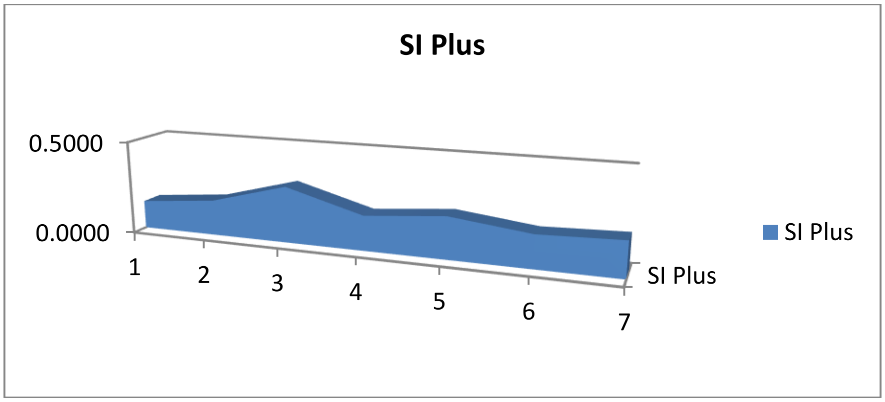

FIGURE 5. SI Plus

This Figure shows TOPSIS method of SI Plus.

TABLE 8. Si Negative

	Si Negative
Safety flexibility of equipment	0.2324
Light shortage	0.1775
Respiratory risks	0.0313
Access to standard equipment	0.1762
Protective equipment for labor	0.1037
Materials safety information and guidelines	0.1428
The relationship between labor and equipment	0.1321

This table shows TOPSIS method of SI Negative. This Figure shows TOPSIS method of SI Negative.

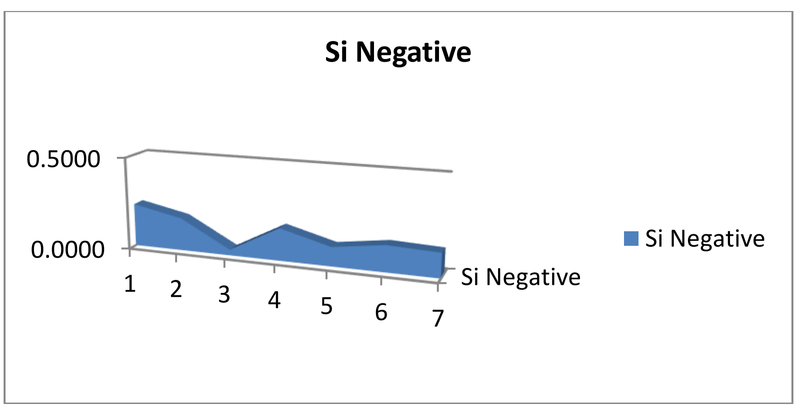

FIGURE 6. Si Negative

TABLE 9. Ci

	Ci
Safety flexibility of equipment	0.6057
Light shortage	0.4820
Respiratory risks	0.0938
Access to standard equipment	0.4848
Protective equipment for labor	0.3151
Materials safety information and guidelines	0.4476
The relationship between labor and equipment	0.4093

This table shows TOPSIS method of CI.

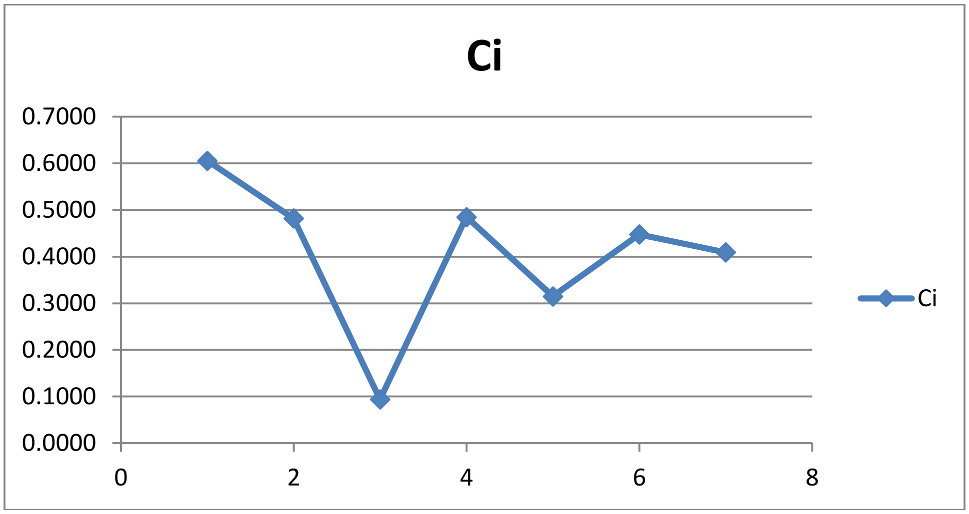

FIGURE 9. Ci

This Figure shows TOPSIS method of CI.

TABLE 10. Rank

	Rank
Safety flexibility of equipment	**1**
Light shortage	**3**
Respiratory risks	**7**
Access to standard equipment	**2**
Protective equipment for labor	**6**
Materials safety information and guidelines	**4**
The relationship between labor and equipment	**5**

This table shows TOPSIS method of Rank. Safety flexibility of equipment 1, Access to standard equipment2, Light shortage 3, Materials safety information and guidelines4, The relationship between labor and equipment5, Protective equipment for labor6, Respiratory risks 7.

FIGURE 10. Rank

This Figure shows TOPSIS method of Rank. Safety flexibility of equipment 1, Access to standard equipment2, Light shortage 3, Materials safety information and guidelines4, The relationship between labor and equipment5, Protective equipment for labor6, Respiratory risks 7.

4. CONCLUSION

This technique combines the advantages Rexene) methods, allowing for a thorough examination of options and the selection of the best choice. The BWM is an effective strategy for rating options through a decision-making process by assessing their relative relevance. It enables decision-makers to select the optimal choice by calculating the maximum positive and least negative effect for each criterion. The BWM provides an organization and systematic technique to examine the relative relevance of criteria by conducting pairwise comparisons. VIKOR, on the other palm, is a multi-criteria process of choice that considers both the average and individual performance of options. It seeks a solution that balances competing objectives and selects the alternative that best meets the decision-maker's preferences. To overcome their separate limitations, the hybrid technique combines the qualities of both systems. The decision-makers are able to assess alternatives in terms of both the relative relevance of criteria in addition to their overall performance by combining the BWM and VIKOR. This hybrid method allows for a more thorough study and a more robust and dependable decision-making framework. Finally, technique is a significant tool for decision-makers confronted with complicated and multi-criteria decision-making situations.

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