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RESEARCH ARTICLE

Strategy Generation for Risk Minimization of Renewable Energy Technology Investments in Hospitals with SF TOP-DEMATEL Methodology

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Abstract: Effective risk management plays an important role to improve renewable energy technology investments. Because of this issue, necessary actions must be implemented to effectively manage these risks. However, having high costs is the biggest disadvantage of the implementation of these actions. Therefore, it is not financially possible to implement different strategies together. In other words, it is necessary to identify the most important of these strategies. Accordingly, the purpose of this study is to make a priority evaluation for the risk strategies related to renewable energy technologies in hospitals. For this purpose, a new model is generated with spherical fuzzy (SF) TOP-DEMATEL technique. In this process, significant indicators are defined based on literature evaluations. In the next process, the weights of these indicators are calculated. The main contribution of this study is that a new technique is proposed by the name of TOP-DEMATEL. In this scope, the final steps of TOPSIS are integrated to the analysis process of DEMATEL to overcome criticisms for classical DEMATEL technique. Moreover, a priority evaluation is carried out to understand the most critical risk management strategies in renewable energy technology investments. With the help of this analysis, it can be much easier to take risk management actions without having financial difficulties. It is determined that the weighting results of the criteria are quite similar for different t values. This situation identifies that the proposed model provides coherent and reliable results. It is concluded that government support is the most important strategy in this context. Additionally, technological improvements also play a crucial role for this situation. It is strongly recommended that governments should establish appropriate legal and regulatory frameworks to promote renewable energy projects. These frameworks can facilitate the financing and licensing of projects and offer economic incentives such as tax incentives and subsidies.

Keywords: fuzzy logic, decision-making models, spherical fuzzy sets, TOP-DEMATEL, renewable energy investments, hospitals

1. Introduction

Renewable energy technology investments refer to investments made in technologies that provide environmentally friendly and sustainable energy production (Ehigiamusoe & Dogan, 2022). They are also very important for hospitals. Renewable energy technologies can reduce the energy costs of hospitals. This creates a more sustainable energy infrastructure of hospitals. Thus, it may be possible to save energy costs in the long run. Hospitals are critical institutions that need uninterrupted energy (Wang & Zhang, 2022). Renewable energy technologies provide energy security to hospitals. In addition, renewable energy investments help hospitals reduce their carbon footprint and minimize their environmental impact (Ali et al., 2023). Thus, hospitals provide services in a more sensitive way toward society and the environment. On the other hand, hospitals' investments in renewable energy create a positive image in society (Gökalp et al., 2021). Hospitals can set an example for other institutions and organizations by taking a leadership role in the use of renewable energy (Gökalp et al., 2022). This shows that hospitals fulfill their social responsibilities and build trust and support among stakeholders (Gawusu et al., 2022).

For renewable energy technologies to be developed effectively, the risks in this process must be minimized. In this context, necessary actions must be implemented to effectively manage these risks (He et al., 2023a). However, the biggest disadvantage of the implementation of these actions is that they create new costs. Therefore, it is not financially possible to implement different strategies together (Wang et al., 2023). Hence, it is necessary to identify the most important of these strategies. In this way, businesses will be able to focus on risk management strategies that are more important, and thus, excessive costs will not arise when

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taking risk management measures. Accordingly, the purpose of this study is to find the most significant risks of renewable energy investment projects. To satisfy this need, this study makes a priority evaluation for the risk strategies related to renewable energy technologies in hospitals. For this purpose, an examination is carried out with spherical fuzzy (SF) TOP-DEMATEL technique. Within this framework, firstly, significant indicators are defined based on literature evaluations. In the next process, the weights of these indicators are calculated.

The main contributions of this study are given below.

(i) A new technique is proposed in this study by the name of TOP-DEMATEL. Classical DEMATEL methodology is criticized by various scholars. For instance, in case of symmetrical evaluation, the criteria weights are defined as equal. However, experts do not think that there should be similar weights. To handle this problem, the final steps of TOPSIS are considered in the analysis process of DEMATEL and TOP-DEMATEL method is generated.

(ii) It is possible to mention some benefits of considering hospitals in the analysis process. Hospitals are critical institutions that need uninterrupted energy. Renewable energy technologies provide energy security to hospitals. Thus, hospitals provide services in a more sensitive way toward society and the environment. In addition, hospitals' investments in renewable energy create a positive image in society. Thus, hospitals can set an example for other institutions and organizations by taking a leadership role in the use of renewable energy.

(iii) The next section consists of literature review. The third section identifies methodology. The fourth section includes analysis results. The final section explains conclusions.

2. Literature Review

In this section, firstly, the importance of providing clean energy in hospitals is explained. After that, the effect of carbon emissions on renewable energy technology investments is evaluated. It is very important that hospitals provide energy sustainability. For this reason, it is necessary to develop energy efficiency and use clean energy (Saqib et al., 2021). In this area of the study, literature studies on energy efficiency in hospitals are included. Alahmer and Alsaqoor (2019) mentioned that hospitals consume a lot of energy and must provide continuous service. In a similar study, Ji and Qu (2019) examined the energy consumption rates by evaluating hospitals in the country of China. As a result of the study, it is found that the energy consumption rates of hospitals in the South China region have the highest share. Li (2021) indicated that smart technology applications have been found to help save energy. In addition, according to Romero and Carnero (2019), energy consumption is very high for the hospitals. On the other hand, emission control and increase in renewable energy consumption could not be developed. Additionally, Balo et al. (2020) also highlighted the significance of energy savings for hospitals.

Also, McGain et al. (2020) examined cutting-edge technology applications within the scope of sustainability. In the study, it is emphasized that fossil fuels should be abandoned. Instead, it is emphasized that the orientation toward renewable energy sources should be realized. In this way, energy efficiency can be achieved. de Oliveira et al. (2021) stated that energy consumption management is a crucial impact for the hospitals. Nourdine and Saad (2021) focused on energy efficiency by examining Moroccan hospitals. As a result, it is concluded that energy performance should be managed effectively. In addition, Dahlan et al. (2022) analyzed Malaysian public hospitals using the energy star score method and reached the similar conclusion. Garg and Dewan (2022) proposed the use of alternative energy sources for the development of the hospital's green concept. In addition, Mashallahi et al. (2022) highlighted the importance of hospitals to adapt to climate change by focusing on more renewable energy sources.

Public investments can be mentioned regarding the effect of the role of technology in renewable energy investments. Ahmed et al. (2022) found that more public investment should be made to improve renewable energy projects in the long run. Similarly, Castrejon-Campos et al. (2022) examined the impact of public investments in clean energy research and development on future technology cost developments. It is concluded that research and development are necessary to minimize this problem. He et al. (2023b) examined public investments for renewable energy development. For this purpose, forecasting strategy, conceptual framework, and empirical model were created. They also highlighted the importance of similar issues. According to Bhattarai et al. (2022), development and application of technology can be affected by direct policy investment. Driscoll (2023) found that investments in renewable energy R&D are most closely related to growth regimes and their associated characteristics. Green finance is also considered while evaluating the role of technology on renewable energy investments. Madaleno et al. (2022) explained the relationship between the new time-varying causality test and green finance. However, this bidirectional causality is not valid for all periods. In addition, Mngumi et al. (2022) presented the link between green finance, renewable energy, and carbon emissions. Moreover, Ge et al. (2022) focused on the impact of green finance and renewable energy technological innovation on the industrial structure. It is concluded that renewable energy technology innovation has significantly contributed to the adjustment of the industrial structure.

Moreover, a stable economy is also critical to minimize the risks of renewable energy technology investments. Izanloo et al. (2022) developed a statistical approach and a hybrid methodology based on machine learning algorithms to structure decisions in renewable energy investments. As a result, fluctuations in electricity prices are considered as a risk on renewable energy technologies. Furthermore, Fahmy (2022) focused on clean energy prices and oil and technology stock prices after the Paris agreement. It is found that the oil price has a stronger asymmetric persistence before the Paris Agreement. Yasmeen et al. (2022) investigated the role of the consumption of the top ten solar energy consuming countries from 1990 to 2018. It has been found that solar energies reduce carbon emissions and can maintain sustainable economic growth by meeting energy demand. Additionally, the effects of technological development on the risks of renewable energy investments are evaluated by many scholars. Fang (2023) mentioned that carbon emission is negatively affected by the effect of energy on green technology and industrial structure.

Ouedraogo et al. (2022) aimed to develop a strategy to solve the technical problem of the implementation of solar power plants in hospitals. Beitelmal et al. (2022) addressed the problems of unstable energy and energy prices of health clinics in rural areas. It is argued that during COVID-19, photovoltaic batteries can benefit economically by lowering energy prices and reducing emissions. Haddock et al. (2022) mentioned that the size of the health sector's carbon footprint is too large and the problem of not clearly specifying the regulations and directives to reduce industry emissions. Ebekozien et al. (2022) carried out to reveal the obstacles to the management of hospitals in Nigeria with the concept of green building. Generally, the use of clean energy is important in sustainable building projects. Therefore, it has been found that there are technological, political, market, human, and information related barriers in this regard. Sittig et al. (2022)

conducted to provide suggestions for providing political and technical strategic approaches by addressing the increasing developments and resource use in health services. Soto et al. (2022) mentioned the difficulties of applying solar energy in health centers. These challenges have been found to be operational, environmental, and economic. Also, Dion et al. (2023) addressed the challenges in using clean energy to achieve energy efficiency in hospitals. As a result of the study, it is determined that cost and policy decisions are not integrated. Govindan et al. (2023) described the barriers to the implementation of blockchain technology under the balanced scorecard. These barriers were found to be financial, security, expertise, vague government decisions, and lack of information. Likewise, Anilkumar et al. (2022) identified barriers to sustainable practice in public hospitals in India. In this context, it has been found that there is a lack of members in the green supply chain. In addition, Azubuike and Adeyemi (2022) addressed the problems of poor clean energy and policy frameworks by emphasizing quality health services.

The main results of the literature examination are demonstrated as follows.

(i) Risks should be minimized to improve renewable energy technology investments.
(ii) Necessary actions must be implemented to effectively manage these risks.
(iii) Having high costs is the biggest disadvantage of the implementation of these actions
(iv) Therefore, it is not financially possible to implement different strategies together. Thus, it is necessary to identify the most important of these strategies.

With the help of this issue, businesses can focus on risk management strategies that are more important, and thus, excessive costs will not arise when taking risk management measures. To satisfy this need, this study makes a priority evaluation for the risk strategies related to renewable energy technologies in hospitals.

3. SF TOP-DEMATEL

DEMATEL calculates the weights of different factors. In this process, the impact directions of these items are taken into consideration. This situation is accepted as a significant superiority of DEMATEL over other similar techniques. However, this method is also criticized because of some points. In this context, when experts make symmetrical evaluations, the weights are computed equally inappropriately. In other words, although experts consider one criterion more important in comparison to the other factor, DEMATEL technique provides the same weights. In this study, for the purpose of overcoming these criticisms, the final steps of TOPSIS are adopted to DEMATEL approach and a new method is created by the name of TOPSIS-based DEMATE (TOP-DEMATEL) (Özdemirci et al., 2023). In the proposed model, this technique is used with SF sets. The main advantage of this new technique is that in the case of symmetrical evaluation, the problem of inaccurately equal calculation of criterion weights can be avoided. In this process, hesitancy, membership, and non-membership degrees (u, s, d) are computed as in Equation (1).

$$0 \leq s^t + u^t + d^t \leq 1 \tag{1}$$

Expert team makes evaluation by using five different scales and these evaluations are converted into the fuzzy sets. Equation (2) gives information Z^i matrix.

$$Z^i = \begin{bmatrix} 0 & \cdots & (s^i_{1n}, u^i_{1n}, d^i_{1n}) \\ \vdots & \ddots & \vdots \\ (s^i_{n1}, u^i_{n1}, d^i_{n1}) & \cdots & 0 \end{bmatrix} \tag{2}$$

Equations (3) and (4) are used to create decision matrix.

$$TSFWAM_W(\tilde{A}_{S1}, \tilde{A}_{S1}, \ldots \tilde{A}_{Sn}) = \left\{ \left[1 - \prod_{i=1}^{n} \left(1 - s^t_{\tilde{A}_{Si}}\right)^{w_i}\right]^{\frac{1}{t}}, \prod_{i=1}^{n} u^{w_i}_{\tilde{A}_{Si}}, \prod_{i=1}^{n} d^{w_i}_{\tilde{A}_{Si}} \right\} \tag{3}$$

$$Z = \begin{bmatrix} 0 & \cdots & (s^d_{1n}, u^d_{1n}, d^d_{1n}) \\ \vdots & \ddots & \vdots \\ (s^d_{n1}, u^d_{n1}, d^d_{n1}) & \cdots & 0 \end{bmatrix} \tag{4}$$

Equations (5) and (6) are considered to define and normalize submatrices (X^s, X^u, and X^d).

$$X = sZ \tag{5}$$

$$s = \min\left[\frac{1}{\max_i \sum_{j=1}^{n} |z_{ij}|}, \frac{1}{\max_j \sum_{i=1}^{n} |z_{ij}|}\right] \tag{6}$$

The submatrices are shown in Equation (7).

$$X^s = \begin{bmatrix} 0 & \cdots & s_{1n} \\ \vdots & \ddots & \vdots \\ s_{n1} & \cdots & 0 \end{bmatrix} \quad X^u = \begin{bmatrix} 0 & \cdots & u_{1n} \\ \vdots & \ddots & \vdots \\ u_{n1} & \cdots & 0 \end{bmatrix} \quad X^d = \begin{bmatrix} 0 & \cdots & d_{1n} \\ \vdots & \ddots & \vdots \\ d_{n1} & \cdots & 0 \end{bmatrix} \tag{7}$$

Equation (8) is taken into consideration to construct total relationship matrix.

$$T = \begin{bmatrix} 0 & \cdots & (\mu^T_{1n}, \eta^T_{1n}, \nu^T_{1n}) \\ \vdots & \ddots & \vdots \\ (\mu^T_{n1}, \eta^T_{n1}, \nu^T_{n1}) & \cdots & 0 \end{bmatrix} \tag{8}$$

The values are defuzzified with Equation (9).

$$Score = \mu^t - \eta^t - \nu^t \tag{9}$$

The weights of the criteria are calculated by Equations (10)–(16).

$$C^*{}_j = \sqrt{\sum_{i=1}^{n} \left(t_i - \max_j t_i\right)^2} \quad j = 1, 2, ..n \tag{10}$$

Table 1
Indicators

Criteria	References
Government support (GOSU)	Ahmed et al. (2022); Castrejon-Campos et al. (2022); He et al. (2023a)
Financial efficiency (FIEF)	Madaleno et al. (2022); Mngumi et al. (2022); Khan et al. (2022a); Ge et al. (2022)
Organizational effectiveness (OREF)	Izanloo et al. (2022); Awan et al. (2022); Fahmy (2022); Sharif et al. (2023); Kalkavan and Eti (2021)
Technological improvements (TEIM)	Fang (2023); Kuang et al. (2022); Khan et al. (2022b); Zhang et al. (2022)
Personnel quality (PRSQ)	Bhattarai et al. (2022); Driscoll (2023); Yasmeen et al. (2022); Baş et al. (2022); Yu et al. (2019)
Benchmarking with the market (BWTN)	Suki et al. (2022)

Table 2
Expert opinions

	Expert 1					
	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0	4	4	4	4	4
FIEF	3	0	1	2	2	1
OREF	3	1	0	3	2	2
TEIM	4	3	4	0	4	4
PRSQ	3	2	1	3	0	1
BWTN	3	2	2	3	1	0
	Expert 2					
	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0	4	3	4	3	4
FIEF	1	0	1	1	1	2
OREF	1	2	0	2	1	2
TEIM	2	3	4	0	3	3
PRSQ	1	1	2	2	0	2
BWTN	1	2	1	1	1	0
	Expert 3					
	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0	4	4	4	3	4
FIEF	1	0	2	1	1	2
OREF	1	1	0	1	1	2
TEIM	3	2	4	0	3	3
PRSQ	1	1	1	2	0	2
BWTN	1	2	2	1	2	0

$$C^-{}_j = \sqrt{\sum_{i=1}^{n}\left(t_i - \min_j t_i\right)^2} \quad j = 1, 2, ..n \tag{11}$$

$$R^*{}_i = \sqrt{\sum_{j=1}^{n}\left(t_j - \max_i t_j\right)^2} \quad i = 1, 2, ..n \tag{12}$$

$$R^-{}_i = \sqrt{\sum_{j=1}^{n}\left(t_j - \max_i t_j\right)^2} \quad i = 1, 2, ..n \tag{13}$$

$$S_i^* = C^* + R_i^* \tag{14}$$

$$S_i^- = C_i^- + R_i^- \tag{15}$$

$$W_i = \frac{S_i^-}{S_i^- + S_i^*} \tag{16}$$

4. Analysis Results

Risk evaluations are made related to the renewable energy technologies in hospitals. For this purpose, an examination is conducted with SF TOP-DEMATEL technique. In this context, firstly, significant indicators are defined based on literature evaluations. The details of these factors are given in Table 1.

In the following stage, expert opinions are collected. The first expert is a professor of energy finance and renewable energy investments. The second expert is a chief financial officer in an energy investment company. The third expert is a general manager in a renewable energy company. Table 2 explains the details of the expert opinions.

In the following step, the decision matrix is created (Table 3).

The next process includes the calculation of the submatrices as in Table 4.

Total relation matrixes for each fuzzy number are created as in Table 5.

Table 6 gives information about the integrated total relation matrix.

Finally, the weights of the criteria are computed for "$t = 2$" as detailed in Table 7.

These results are also given in Figure 1.

It is concluded that government support has the greatest weight (0.1786). Additionally, technological improvements also play a crucial role in this framework. States can establish appropriate legal and regulatory frameworks to promote renewable energy projects. These frameworks can facilitate the financing and licensing of projects and offer economic incentives such as tax incentives and subsidies. On the other hand, governments can provide financial support such as incentives, grant programs, low-interest loans, and tax breaks to finance renewable energy

Table 3
Decision matrix

D	GOSU			FIEF			OREF			TEIM			PRSQ			BWTN		
GOSU	0.00	0.00	0.00	0.85	0.15	0.45	0.80	0.17	0.41	0.85	0.15	0.45	0.72	0.18	0.38	0.85	0.15	0.45
FIEF	0.37	0.26	0.20	0.00	0.00	0.00	0.21	0.28	0.18	0.21	0.28	0.18	0.21	0.28	0.18	0.29	0.27	0.21
OREF	0.37	0.26	0.20	0.21	0.28	0.18	0.00	0.00	0.00	0.42	0.25	0.24	0.21	0.28	0.18	0.35	0.25	0.25
TEIM	0.68	0.20	0.34	0.54	0.22	0.31	0.85	0.15	0.45	0.00	0.00	0.00	0.72	0.18	0.38	0.72	0.18	0.38
PRSQ	0.37	0.26	0.20	0.21	0.28	0.18	0.21	0.28	0.18	0.46	0.23	0.28	0.00	0.00	0.00	0.29	0.27	0.21
BWTN	0.37	0.26	0.20	0.35	0.25	0.25	0.29	0.27	0.21	0.37	0.26	0.20	0.21	0.28	0.18	0.00	0.00	0.00

Table 4
Submatrices

D^M	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.0000	0.8500	0.7958	0.8500	0.7181	0.8500
FIEF	0.3718	0.0000	0.2065	0.2065	0.2065	0.2888
OREF	0.3718	0.2065	0.0000	0.4183	0.2065	0.3500
TEIM	0.6796	0.5376	0.8500	0.0000	0.7181	0.7181
PRSQ	0.3718	0.2065	0.2065	0.4584	0.0000	0.2888
BWTN	0.3718	0.3500	0.2888	0.3718	0.2065	0.0000
D^U	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.0000	0.1500	0.1651	0.1500	0.1817	0.1500
FIEF	0.2621	0.0000	0.2823	0.2823	0.2823	0.2657
OREF	0.2621	0.2823	0.0000	0.2466	0.2823	0.2500
TEIM	0.1957	0.2154	0.1500	0.0000	0.1817	0.1817
PRSQ	0.2621	0.2823	0.2823	0.2321	0.0000	0.2657
BWTN	0.2621	0.2500	0.2657	0.2621	0.2823	0.0000
D^L	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.0000	0.4500	0.4138	0.4500	0.3806	0.4500
FIEF	0.1990	0.0000	0.1778	0.1778	0.1778	0.2109
OREF	0.1990	0.1778	0.0000	0.2359	0.1778	0.2500
TEIM	0.3402	0.3129	0.4500	0.0000	0.3806	0.3806
PRSQ	0.1990	0.1778	0.1778	0.2797	0.0000	0.2109
BWTN	0.1990	0.2500	0.2109	0.1990	0.1778	0.0000

Table 5
Total relation submatrices

T^M	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.3955	0.6850	0.6376	0.6950	0.6465	0.6506
FIEF	0.3074	0.1380	0.2158	0.2311	0.2271	0.2445
OREF	0.3434	0.2575	0.1692	0.3422	0.2608	0.2982
TEIM	0.6289	0.5302	0.6147	0.3385	0.6056	0.5679
PRSQ	0.3445	0.2580	0.2521	0.3577	0.1706	0.2780
BWTN	0.3421	0.3125	0.2771	0.3224	0.2582	0.1679
T^U	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.2501	0.2926	0.2967	0.2907	0.2985	0.2943
FIEF	0.4633	0.4038	0.4749	0.4713	0.4721	0.4733
OREF	0.4519	0.4624	0.3916	0.4520	0.4606	0.4583
TEIM	0.3325	0.3413	0.3274	0.2840	0.3327	0.3360
PRSQ	0.4532	0.4637	0.4649	0.4502	0.3933	0.4631
BWTN	0.4502	0.4539	0.4580	0.4536	0.4588	0.3899
T^L	GOSU	FIEF	OREF	TEIM	PRSQ	BWTN
GOSU	0.4009	0.6248	0.5961	0.6438	0.6013	0.6070
FIEF	0.3373	0.1861	0.2862	0.3014	0.2970	0.3004
OREF	0.3579	0.3107	0.2044	0.3518	0.3162	0.3386
TEIM	0.5839	0.5105	0.5686	0.3455	0.5562	0.5307
PRSQ	0.3629	0.3145	0.3112	0.3801	0.2098	0.3237
BWTN	0.3532	0.3450	0.3175	0.3274	0.3114	0.2007

Table 7
Weights

Indicators	Significance weights
GOSU	0.1786
FIEF	0.1480
OREF	0.1689
TEIM	0.1729
PRSQ	0.1665
BWTN	0.1651

Figure 1
Weights of the indicators

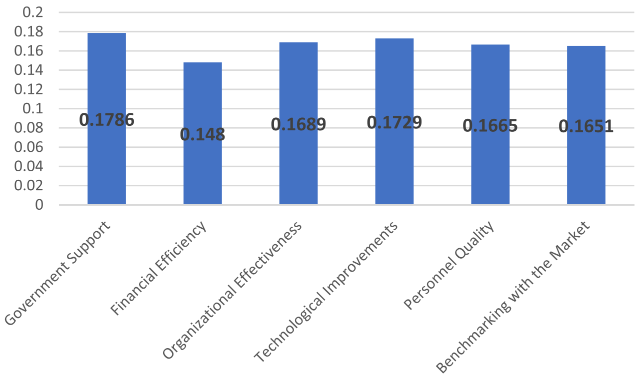


Table 8
Weights for different *t* values

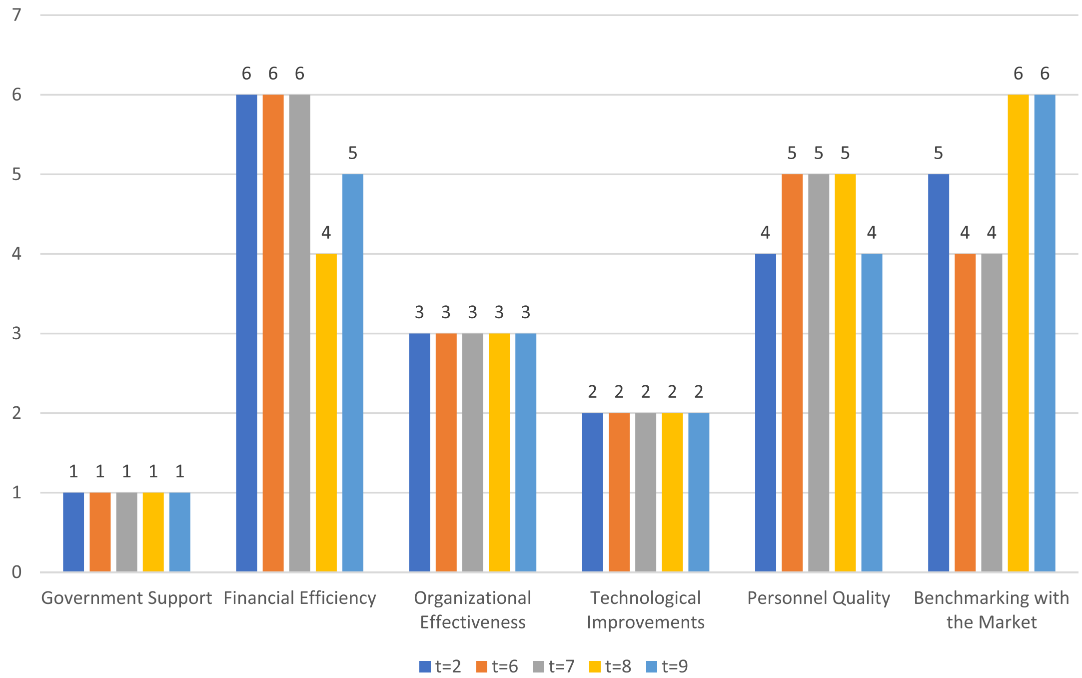
	Weights				
	t = 2	*t* = 6	*t* = 7	*t* = 8	*t* = 9
GOSU	0.1786	0.1951	0.2057	0.2207	0.2300
FIEF	0.1480	0.1446	0.1445	0.1388	0.1286
OREF	0.1689	0.1641	0.1562	0.1520	0.1512
TEIM	0.1729	0.1814	0.2040	0.2177	0.2298
PRSQ	0.1665	0.1563	0.1448	0.1364	0.1321
BWTN	0.1651	0.1585	0.1449	0.1345	0.1283

projects. This lowers investors' costs and reduces their risk. Moreover, states can cooperate internationally to increase their renewable energy investments. It can support renewable energy projects by collaborating on technology transfer, financing, and experience sharing. In addition, a sensitivity analysis has also been performed by considering different t values (Table 8).

Table 6
Integrated total relation matrix

T	GOSU			FIEF			OREF			TEIM			PRSQ			BWTN		
GOSU	0.40	0.25	0.40	0.69	0.29	0.62	0.64	0.30	0.60	0.70	0.29	0.64	0.65	0.30	0.60	0.65	0.29	0.61
FIEF	0.31	0.46	0.34	0.14	0.40	0.19	0.22	0.47	0.29	0.23	0.47	0.30	0.23	0.47	0.30	0.24	0.47	0.30
OREF	0.34	0.45	0.36	0.26	0.46	0.31	0.17	0.39	0.20	0.34	0.45	0.35	0.26	0.46	0.32	0.30	0.46	0.34
TEIM	0.63	0.33	0.58	0.53	0.34	0.51	0.61	0.33	0.57	0.34	0.28	0.35	0.61	0.33	0.56	0.57	0.34	0.53
PRSQ	0.34	0.45	0.36	0.26	0.46	0.31	0.25	0.46	0.31	0.36	0.45	0.38	0.17	0.39	0.21	0.28	0.46	0.32
BWTN	0.34	0.45	0.35	0.31	0.45	0.35	0.28	0.46	0.32	0.32	0.45	0.33	0.26	0.46	0.31	0.17	0.39	0.20

Figure 2
Ranking of criteria for different *t* values



The ranking results of the criteria based on weighting results of different t values are illustrated in Figure 2.

It is determined that the weighting results of the criteria are quite similar for different t values. This situation identifies that the proposed model provides coherent and reliable results.

5. Discussions and Conclusion

This study aims to make risk evaluations regarding the renewable energy technologies in hospitals. For this purpose, an examination is conducted with SF TOP-DEMATEL technique. In this context, firstly, significant indicators are defined based on literature evaluations. After that, the weights of these indicators are computed. The findings indicate that government support has the highest weight. Furthermore, technological improvements also play a significant role in this context. It is strongly recommended that governments should establish appropriate legal and regulatory frameworks to promote renewable energy projects. These frameworks can facilitate the financing and licensing of projects and offer economic incentives such as tax incentives and subsidies. Additionally, governments should also provide financial support such as incentives, grant programs, low-interest loans, and tax breaks to finance renewable energy projects.

According to the results of the analysis, the most important factor affecting renewable energy technology investment in hospitals is government support. In this framework, government support should be carried out effectively to increase investments in renewable energy technology investments. In this context, it would be appropriate for governments to develop policies to encourage businesses to invest in renewable energy technology. However, to develop these policies, it would be appropriate to carry out the necessary studies and identify the issues that need to be addressed. Apart from this, another important factor affecting renewable energy technology investments is that businesses keep up with the developing technology. A hospital that follows technological developments will be able to adapt to renewable energy technologies. This will pave the way for these investments. In addition, the quality of the personnel who will follow technological developments and use this technology affects the process in question. Hospitals should employ staff to meet these needs or provide training to their existing staff in this direction. Another important factor that will affect this process is the organizational efficiency of the hospital. Hospitals with high organizational efficiency are more likely to invest in renewable energy technologies.

Many studies in the literature argue that government subsidies are necessary for the development of renewable energy technology investments. Bai et al. (2021) conducted a study investigating how the relationship between government subsidies and renewable energy investment depends on firm size. Using panel data from firms in China, the study concluded that renewable energy investments and government subsidies are directly related. Abban and Hasan (2021) and Wu et al. (2020) studied the relationship between government subsidies and investments in the renewable energy sector. According to the results of the studies, the right government incentive policies contribute to renewable energy investments. Wu and Song (2023) stated that government support is important for the development of renewable energy. Liu et al. (2022) point out a study using data from European Union countries between 2000 and 2020. Accordingly, it is specified that the state has an important role in increasing renewable energy investments. Boute (2020) defined study examining renewable energy investments and state stability. In the study run in Kazakhstan, the regulatory stability model was used. Accordingly, it was remarked that states should integrate a certain degree of regulatory flexibility into renewable energy support programs.

Another important result obtained in our study is that technological development should be ensured to increase investments in renewable energy technologies. Fang (2023) stated that technological development directly affects renewable energy investments. Kuang et al. (2022) analyzed the effects of green technology innovations and renewable energy investments on carbon emissions in China. In the study carry out using data from 1990 to 2018, it is emphasized that enterprises that keep up with technological developments are more advantageous in renewable energy investments. Zhang et al. (2022) point out a study with a regression model using data from G20 countries between 2008 and 2018. In the study examining the relationship between renewable energy investments and R&D, the importance of technology is mentioned. He et al. (2023b) conducted a study investigating the role of renewable energy in combating climate change. Accordingly, the study, which argues that renewable energy investments should be increased, also mentions the great contribution of technology.

The main contribution of this study is that a new technique is proposed by the name of TOP-DEMATEL. Classical DEMATEL methodology is criticized by various scholars. To minimize this problem, the final steps of TOPSIS are considered in the analysis process of DEMATEL and TOP-DEMATEL method is generated. Hence, methodological originality of the study can be increased. Additionally, a priority evaluation is carried out to understand the most critical risk management strategies in renewable energy technology investments. With the help of this analysis, it can be much easier to take risk management actions without having financial difficulties. However, making evaluation for only hospital is the main limitation. For the future research directions, different industries can be examined, such as banking, textile, and telecommunication. Another limitation of the study is that there is no alternative ranking. In the next studies, a country group can be ranked by using different techniques, such as MOORA and VIKOR.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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