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RESEARCH ARTICLE

OPTIMIZING EMPLOYEE AWARENESS STRATEGIES FOR ENERGY EFFICIENCY IN HEALTHCARE: A COMPARATIVE STUDY USING PICTURE FUZZY CIMAS AND SIWEC

Yaşar Gökalp[1], Serkan Eti [2,3], Sefer Aygün[1], Sadiq Hussain[4]*

1. The School of Health Science, İstanbul Medipol University, Istanbul, Türkiye
2. Faculty of Applied Science, Marmara University , İstanbul, Türkiye
3. ARUCAD Research Centre, Arkin University of Creative Arts and Design, Kyrenia, Northern Cyprus
4. Centre for Computer Science and Application, Dibrugarh University, Dibrugarh, India

*Correspondence: saygun@medipol.edu.tr

ABSTRACT

BACKGROUND:
Hospitals are in the category of buildings that consume the most energy. Considering these characteristics of hospitals, energy efficiency becomes important. For this reason, healthcare professionals are seen as an important factor in ensuring energy efficiency in hospitals. The purpose of this study is to identify the priority strategies required to increase the awareness level of hospital employees on energy efficiency.

METHODS:
In line with the aim of the study, healthcare worker factors affecting efficiency in hospitals are determined based on the literature. After that, the importance weights of these criteria are calculated using the picture fuzzy criteria importance assessment (CIMAS) technique. In addition, a comparative analysis is carried out with the picture fuzzy simple weight calculation (SIWEC) approach.

RESULTS:
The main contribution of the study is to determine the optimum employee strategies to provide energy efficiency. This issue has a guiding feature for hospital managers and policymakers. It is concluded that the most important criterion for these employees is reward programs (w=0.209). The second most important factor is found as creating energy-saving awareness (w=0.185).

CONCLUSIONS:
To achieve this goal, it would be beneficial to apply motivating factors to employees. In addition, increasing the awareness level of employees makes a significant contribution.

KEYWORDS
CIMAS, SIWEC, healthcare, employee awareness, picture fuzzy

INTRODUCTION

Energy efficiency means less energy consumption for the same amount of work or service [1]. With developing technology and increasing population, energy consumption is also growing. Accordingly, ensuring energy efficiency is inevitable. Hospitals are in the category of buildings with the highest energy consumption [2]. The increasing life expectancy at birth, the aging population, and increasing chronic diseases cause an increase in the level of applications to health services. Therefore, the energy consumption in hospitals is also increasing day by day. While energy efficiency is an important issue, it becomes even more crucial for hospitals when these characteristics of hospitals are taken into consideration. Also, healthcare workers are in an important position in ensuring energy efficiency in hospitals [3].

It is obvious that actions taken by healthcare professionals can affect the efficiency level in hospitals [4]. Creating energy-saving awareness among healthcare professionals can largely prevent unnecessary energy consumption. In addition, reward programs for successful healthcare professionals are a motivating factor [5]. Legal processes aimed at ensuring energy efficiency may make it mandatory for healthcare institutions to meet their energy targets [6]. The use of smart technologies such as automatic lighting and smart thermostats contributes positively to energy efficiency. In addition, the economical selection of medical devices and regular maintenance is important in terms of ensuring efficiency [7].

Energy efficiency in hospitals is important not only for sustainable healthcare services but also for economic growth [8]. Healthcare workers also play a key role in ensuring energy efficiency in hospitals. Therefore, improvements should be made in factors related to healthcare workers to ensure energy efficiency in hospitals. However, each improvement leads to an increase in costs. Making improvements to each factor can lead to cost increases that may negatively affect the performance of businesses. Therefore, making improvements to priority factors is the ideal solution. However, there are very few studies in the literature addressing this issue. In this context, a new study is needed to determine the most important variables for healthcare workers to ensure energy efficiency in hospitals.

This study aims to determine the priority strategies required to increase the awareness level of hospital employees on energy efficiency. In this process, firstly, 6 different criteria are determined as a result of a comprehensive literature analysis. After that, the importance weights of these criteria are calculated using the picture fuzzy CIMAS technique. In addition, a comparative analysis is carried out with the picture fuzzy SIWEC approach. Owing to this issue, it is possible to test the consistency of the results.

This study includes five different sections. Literature review is performed in the following step. Proposed methodology is explained in the third part. The results of this proposed model are defined in the fourth part. In the following sections, discussion and conclusion are determined.

One of the important factors affecting energy efficiency in hospitals is the creation of energy awareness among healthcare professionals [9]. Hospitals are buildings with the highest energy consumption [10]. Therefore, the awareness of hospital staff about energy consumption positively affects energy efficiency. Education and awareness activities for healthcare professionals change the energy consumption behaviors of employees. This also reveals the sustainability mission of the institution [11]. Zhang et al. (2023) examined the role of globalization and education in promoting energy efficiency. It is underlined that education has an important role in terms of energy efficiency in the development of energy policies [12]. Fang and Li (2024) carried out the relationship between corporate sustainability and highly educated employees. It is understood from the results of the study that employee education makes a great contribution to sustainability [13].

Reward programs for healthcare workers are important in terms of increasing energy efficiency [14]. To increase energy efficiency, employees need to change their behavior. The reward system is an ideal method to ensure this change and gain positive habits. In addition, the evolution of corporate culture towards increasing energy efficiency is directly related to healthcare workers [15]. Marrucci et al. (2024) conducted a study aiming to establish environmental performance indicators. It is stated that the reward system for employees facilitates the achievement of goals [16]. Mungai et al. (2023) performed a study revealing the factors affecting the adoption of energy efficiency practices. It is argued that providing employees with training and motivating rewards will increase energy efficiency [17].

Another important issue affecting the increase in energy efficiency in hospitals is legal processes [18]. The obligation to train and raise awareness of personnel can be determined by legal limits. In addition, supervision of this process can increase efficiency practices. Determining the criteria in the performance evaluation processes of personnel according to energy efficiency can be an important step [19]. He and Wang (2024) examined the relationship between the establishment of environmental courts in China and the increase in energy efficiency. The results of the study show that the established environmental courts increase energy efficiency [20]. Yasmeen et al. (2023) investigated energy efficiency from the perspective of the rule of law in OECD countries. It is seen that legal procedures have an important place in terms of energy efficiency [21].

As a result of the literature review, it is possible to underline some important points. Most of the studies are studying the need to achieve energy efficiency. However, the number of studies on which factors come to the forefront to ensure efficiency is quite limited. In addition, studies conducted specifically for hospitals, where energy consumption is the highest, are also limited. Besides, a significant portion of energy consumption is related to healthcare workers. Therefore, conducting a prioritization study for personnel to ensure energy efficiency can fill an important gap in the literature. A model was established with multi-criteria decision-making techniques to determine prioritization strategies.

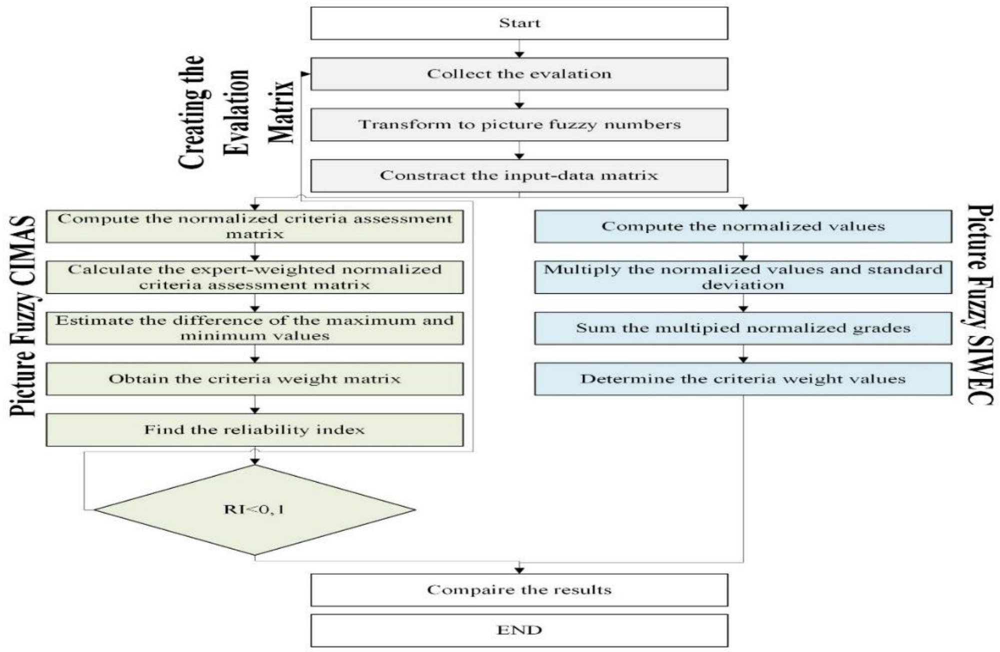
METHODOLOGY

Since strategies that can be applied to healthcare workers to ensure energy efficiency in hospitals play a critical role in achieving energy saving targets, determining the most applicable strategy constitutes the main purpose of the study. In this context, strategies need to be evaluated and prioritized. However, since numerical data is not possible for evaluations, multi-criteria decision-making techniques are used to solve this problem. The CIMAS and SIWEC methods are current methods that prioritize factors on a target using expert importance ratings [22]. The CIMAS method is preferred because the reliability of the results can be tested, and the SIWEC method is preferred because it forces experts to make more realistic evaluations [18]. In addition, the same initial matrices allow the results to be compared. In addition to these two method choices, fuzzy numbers are used to include linguistic uncertainty in the analysis. The schematic representation of the steps of the study in which the methods are integrated with picture fuzzy sets is presented in Figure 1.

ETHICAL APPROVAL

This study is based solely on professional expert assessments within the framework of multi-criteria decision-making (MCDM) methodology. The study methodology and Istanbul Medipol University's institutional guidelines and national legislation (YÖK Scientific Research and Publication Ethics Directive) exempt it from official ethics committee approval. The research does not involve any human experiments, animal experiments, clinical trials, or psychological/physical interventions. Furthermore, the study was conducted in full compliance with Law No. 6698 on the Protection of Personal Data (KVKK). No identifiable medical or personal data was collected or processed. The data used in the analysis consists solely of professional opinions provided by experts in the relevant fields for technical weighting purposes. Additionally, informed consent was obtained from all experts before their participation in the study, and expert participation was entirely anonymous and voluntary.

FIGURE 1: THE SCHEMATIC REPRESENTATION OF THE STEP



EXPERT SELECTION

The expert team consists of 5 specialists with at least 15 years of experience. They have been selected from individuals with knowledge and experience in hospital management. The experts providing opinions serve as hospital directors, hospital deputy directors, academics, and technical services directors. Their educational backgrounds are postgraduate and above.

CIMAS WITH PICTURE FUZZY SETS

The Criteria Importance Assessment (CIMAS) method is a multi-criteria decision-making technique that uses experts' evaluations of the criteria and considers the experience and knowledge level of the experts. Another advantage of this method, which emphasizes the evaluation of the best expert, is that it can provide consistent analysis of the results, as in AHP. The analysis steps performed by integrating with Picture fuzzy numbers are detailed below.

First, experts are asked to evaluate each criterion separately. The linguistic evaluations are then transformed into picture fuzzy numbers, and the input-data matrix is constructed. The input-data matrix is shown with the help of Equation (1).

$$\widetilde{ID} = \begin{matrix} . \\ E_1 \\ \vdots \\ E_k \end{matrix} \begin{matrix} C_1 & \cdots & C_n \\ \begin{bmatrix} (P_{11}, F_{11}, S_{11}) & \cdots & (P_{1n}, F_{1n}, S_{1n}) \\ \vdots & \ddots & \vdots \\ (P_{k1}, F_{k1}, S_{k1}) & \cdots & (P_{kn}, F_{kn}, S_{kn}) \end{bmatrix} \end{matrix} \quad (1)$$

Where, k and n are the numbers of experts and criteria, respectively. (P_{ij}, F_{ij}, S_{ij}) is the picture fuzzy number of expert-i's evaluation of criterion-j. Moreover, P, F and S are the positive membership, neutral membership, and negative membership of the picture fuzzy number, respectively. Afterwards, the score values of the picture fuzzy number elements of the input-data matrix are calculated with Equation (2).

$$score(P_{ij}, F_{ij}, S_{ij}) = \frac{1}{3}\left(P_{ij} + (1 - F_{ij}) + (1 - S_{ij})\right) \quad (2)$$

The matrix created by the score function in Equation (2) is normalized. The element of normalized criteria assessment matrix is computed using Equation (3)

$$n_{ij} = \frac{score(P_{ij}, F_{ij}, S_{ij})}{\sum_{e=1}^{k} score(P_{ej}, F_{ej}, S_{ej})} \quad (3)$$

Where, n is element of the normalized criteria assessment matrix (ꞃ). Then, the expert-weighted normalized criteria assessment matrix is computed by Equation (4).

$$r_{ij} = n_{ij} w_i \quad (4)$$

Where w_i means the weights of expert-i, and the weight are obtained with the help of Equation (5).

$$w_i = \frac{exp_i}{\sum_{e=1}^{k} exp_e} \quad (5)$$

Where, exp_i represents the experience of expert-i. Afterwards, the maximum and minimum values of each criterion in the expert-weighted normalized criteria assessment matrix are identified by Equations (6) and (7).

$$x_j^{max} = \max_i r_{ij} \quad (6)$$

$$x_j^{min} = \min_i r_{ij} \quad (7)$$

Next, the differences of the maximum and minimum values are performed using Equation (8).

$$v_j = x_j^{max} - x_j^{min} \quad (8)$$

Finally, the criteria weight matrix is determined with Equation (9).

$$cw_j = \frac{v_j}{\sum_{e=1}^{n} v_e} \quad (9)$$

After the weights of the criteria are determined, results are tested by calculating the reliability index such as AHP. For this, a second evaluation is collected from experts. In this evaluation, the criteria are evaluated between 0-100. This evaluation expresses the percentage importance of each criterion. Using the weights obtained in the first evaluation and the percentages in the second evaluation, the reliability index is calculated with the help of Equation (10).

$$RI = \frac{\sum_{j=1}^{n} \left| 100cw_j - pi_j^{2st} \right|}{100} \quad (10)$$

Where, pi_j^{2st} equals the percentage importance of criteria-j at the second evaluation. If the value of the reliability index is less than 0.1, the prioritization result is reliable.

SIWEC WITH PICTURE FUZZY SETS

The SIWEC method is a multi-criteria decision-making technique that uses the standard deviation of experts' evaluations as important weights. This method gives more importance to experts who show the rating of the criteria more widely and the distinction of importance of the criteria more clearly. The steps of SIWEC performed by integrating with Picture fuzzy numbers are presented below.

After the matrix in Equation (1) is created with expert evaluation, defuzzified values are obtained using Equation (2). Next, the normalized values are computed with the help of Equation (11).

$$n_{ij} = \frac{score(P_{ij}, F_{ij}, S_{ij})}{\max\left(score(P_{ij}, F_{ij}, S_{ij})\right)} \quad (11)$$

Afterwards, the standard deviations of normalized values of each expert are calculated and the normalized values are multiplied with standard deviations using Equation (12).

$$\varsigma_{ij} = n_{ij} std_i \quad (12)$$

In the next step, all multiplied normalized grades are summed by Equation (13).

$$s_j = \sum_{i=1}^{k} \varsigma_{ij} \quad (13)$$

Finally, the criteria weight values are determined with Equation (14).

$$cw_j = \frac{s_j}{\sum_{e=1}^{n} s_e} \quad (14)$$

ANALYSIS

Strategies for healthcare workers to ensure energy efficiency in hospitals are obtained through literature and field scanning. The identified strategies are shared in Appendix Table 1. The strategies in Table 1 are evaluated with linguistic expressions by 5 different experts. These experts have at least 15 years of experience. After that, linguistic expressions are transformed to picture fuzzy numbers, and the input-data matrix as Equation (1) is formed. The input-data matrix is displayed in Table 1.

TABLE 1: THE INPUT-DATA MATRIX

	ENGSVAW			EFFUSE			RWDPRG			SMRTECH			ENGEFFPL			LGLPRCS		
Expert1	.995	.000	.000	.755	.043	.050	.995	.000	.000	.825	.015	.015	.510	.135	.250	.225	.390	.263
Expert2	.755	.043	.050	.755	.043	.050	.825	.015	.015	.825	.015	.015	.650	.131	.137	.225	.390	.263
Expert3	.825	.015	.015	.650	.131	.137	.825	.015	.015	.755	.043	.050	.650	.131	.137	.150	.400	.295
Expert4	.755	.043	.050	.650	.131	.137	.650	.131	.137	.755	.043	.050	.510	.135	.250	.260	.260	.260
Expert5	.755	.043	.050	.510	.135	.250	.825	.015	.015	.650	.131	.137	.260	.260	.260	.225	.390	.263

Afterwards, with the help of Equation (2), the score values of the value in the input-data matrix are calculated. The defuzzified values are illustrated in Appendix Table 2. In the other step, the element of normalized criteria assessment matrix is computed using Equation (3). The normalized criteria assessment matrix is shown below as Appendix Table 3. Next, the expert weighted normalized criteria assessment matrix is estimated using experience of expert and Equation (4). The weights of expert's experience calculated with the help of Equation (5) are 0.238, 0.197, 0.212, 0.147 and 0.207, respectively. The expert-weighted normalized criteria evaluation matrix calculated at the end of this step is given below as Table 2.

TABLE 2: THE EXPERT-WEIGHTED NORMALIZED CRITERIA ASSESSMENT MATRIX

	ENGSVAW	EFFUSE	RWDPRG	SMRTECH	ENGEFFPL	LGLPRCS
Expert1	.052	.052	.052	.050	.047	.047
Expert2	.038	.043	.040	.041	.044	.039
Expert3	.043	.041	.043	.042	.047	.039
Expert4	.028	.029	.025	.029	.029	.032
Expert5	.040	.036	.042	.037	.033	.041

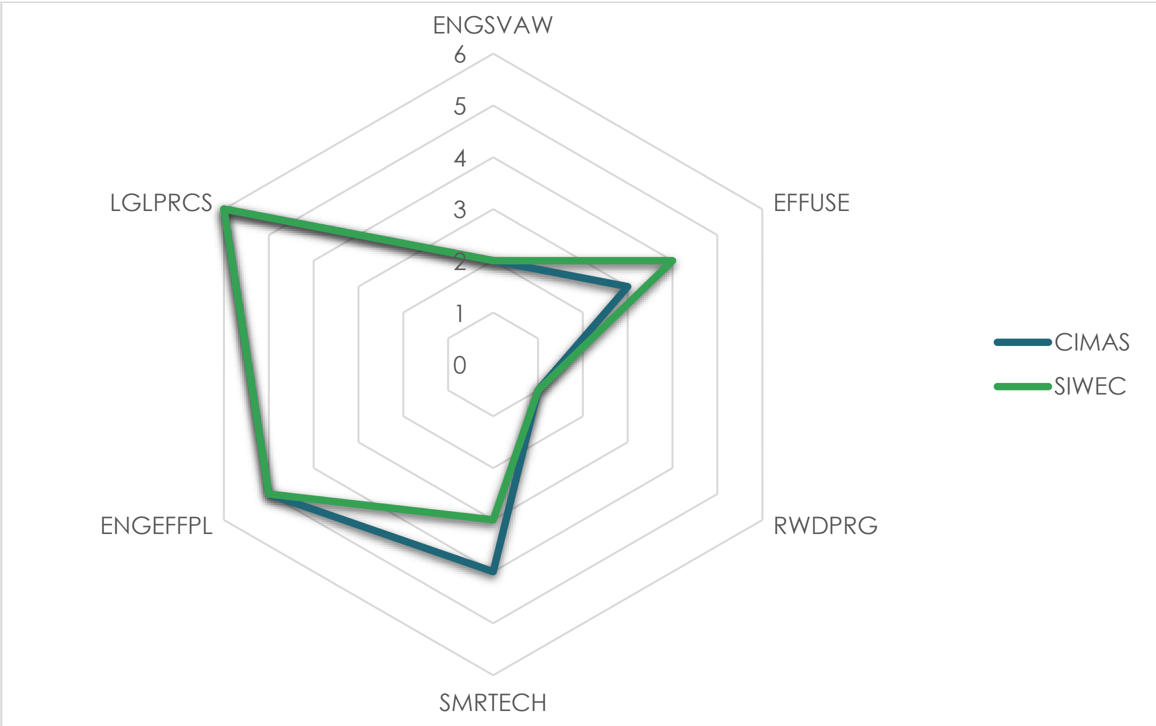
Afterwards, by Equations (6) and (7), the maximum and minimum values are obtained. Then, Equation (8) gives information about the differences between these values. These results are summarized in Table Appendix Table 4. Finally, the weight matrix of strategies is created using Equation (9). The matrix is illustrated in Table 3.

TABLE 3: THE CRITERIA WEIGHTS

	ENGSVAW	EFFUSE	RWDPRG	SMRTECH	ENGEFFPL	LGLPRCS
cw	.185	.184	.209	.163	.142	.118

The reliability index of the analyses is calculated. For this, the percentage importance is obtained from the same five experts again and Equation (10) is calculated. The calculated RI value is 0.08, which is less than 0.1. Therefore, the results are reliable. In addition, the SIWEC method is used for the validity of the results. Using Equations (11)-(14), the weights of the criteria are obtained with the SIWEC method. The comparative results are visualized in Figure 2.

FIGURE 2: THE COMPARATIVE RESULTS



Correlation analysis is performed between the priorities of the criteria obtained by the two methods. The correlation coefficient is calculated as 0.943. This shows that the results are valid. According to the results of the two methods, creating energy saving awareness and reward programs are the most important strategies for healthcare workers to ensure energy efficiency in hospitals.

DISCUSSION

The analysis results show that the most optimal strategy to be implemented for healthcare workers is the reward program. The reward system ensures that the behavioral changes in employees are in the desired direction. In addition, an effective reward system positively affects the motivation of employees. Moreover, the reward system is important to create a sustainable energy efficiency culture in the hospital. Marrucci et al. (2024) conducted a study on the establishment of environmental performance indicators to ensure corporate sustainability and reward employees. It is stated that a good reward system is needed to ensure the expected behavioral change [16]. Mungai et al. (2023) examined the factors affecting energy efficiency practices for 852 companies in 14 sectors in Kenya. It is argued that the reward system based on environmental performance is effective in energy saving [17]. The fact that the reward system is considered most important in the healthcare sector can be explained by the sector's high workload and emotionally demanding nature. There is a need to strengthen the institutional recognition mechanism so that healthcare workers do not perceive the task of saving energy while providing public services as an “additional burden.”

The second most important factor affecting energy efficiency is the creation of energy-saving awareness. The high level of awareness of employees on this issue is important for the success of corporate energy management. Since employees are an important part of energy consumption, it makes it easier to achieve sustainability goals. Employees who are conscious of energy efficiency contribute to energy efficiency not only in the hospital but also in the entire environment they are in contact with. Gökalp et al. (2022) conducted a study on reducing energy costs in hospitals. The results of the study show that the most important factor affecting costs is the awareness level of employees [23]. Kotsopoulos et al. (2023) examined the determinants of energy consumption and savings of employees in the workplace. It is seen that the awareness level has an important place in consumption and savings [24]. Due to the nature of the services provided in hospitals, medical priorities may take precedence over technical efficiency. Therefore, raising awareness has become an important requirement for achieving energy efficiency.

CONCLUSION

This study aims to develop strategies for healthcare workers to ensure energy efficiency for hospitals, which are among the buildings with the highest energy consumption. However, there are multiple factors affecting this issue. Moreover, improving all the factors would cause extra costs. Therefore, there is a need to weigh the criteria for achieving energy efficiency. For this purpose, CIMAS and SIWEC methods were used in the analysis phase. While CIMAS can test the reliability of the results, SIWEC is a method that guides experts to make more realistic assessments. In addition, fuzzy numbers were used to minimize uncertainty. It is concluded that the most optimal strategy to be implemented for the staff while achieving energy efficiency in hospitals is a reward program. Furthermore, to achieve this goal, employees need to be made aware.

A reward system is important to achieve energy efficiency. Some strategies can be considered to serve this goal. Motivating employees on energy efficiency helps to achieve the target. While providing this motivation, salary payment or extra leave rights can be applied. Determining the employee of the month is also an effective practice to ensure efficiency. Furthermore, the unit that achieves the greatest energy savings should be awarded the title of "Environmental Unit of the Year." Covering the participation fees of employees who meet savings targets for international conferences is an important motivational tool. In addition, training to raise the awareness of employees would be useful. The main contribution of this study is the combination of CIMAS, which tests the reliability of the results, and SIWEC, which provides more realistic expert assessments, resulting in more accurate results. Also, it provides a comparable structure, which is an important feature. Furthermore, it is an important contribution that this study is conducted on employees to ensure energy efficiency. The main limitation of this study is that it was conducted in hospitals. Future studies can be applied to other sectors such as automotive and textile.

AVAİLABİLİTY OF DATA AND MATERİALS:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

COMPETİNG İNTERESTS:

The authors declare that they have no competing interests

AUTHORS' CONTRİBUTİONS:

YA wrote the abstract and the background section; SE wrote the methods and result section; SA and SH wrote the conclusion.

References

1. Dincer H, Eti S, Yüksel S, Gökalp Y, Çelebi B. Strategy generation for risk minimization of renewable energy technology investments in hospitals with SF TOP-DEMATEL methodology. J Comput Cogn Eng. 2024.
2. Eti S, Dinçer H, Yüksel S, Gökalp Y. Analysis of the suitability of the solar panels for hospitals: A new fuzzy decision-making model proposal with the T-spherical TOP-DEMATEL method. J Intell Fuzzy Syst. 2023;44(3):4613–25.
3. Ma S, Deng W, Lu J, Zhou T, Liu B. Investigation of thermal comfort and preferred temperatures for healthcare staff in hospitals in Ningbo, China. J Build Eng. 2023;80:108029.
4. As M, Bilir T. Machine learning algorithms for energy efficiency: Mitigating carbon dioxide emissions and optimizing costs in a hospital infrastructure. Energy Build. 2024;318:114494.
5. Psillaki M, Apostolopoulos N, Makris I, Liargovas P, Apostolopoulos S, Dimitrakopoulos P, et al. Hospitals' energy efficiency in the perspective of saving resources and providing quality services through technological options: A systematic literature review. Energies. 2023;16(2):755.
6. Dzwigol H, Kwilinski A, Lyulyov O, Pimonenko T. The role of environmental regulations, renewable energy, and energy efficiency in finding the path to green economic growth. Energies. 2023;16(7):3090.

7. Sundaramoorthy S, Kamath D, Nimbalkar S, Price C, Wenning T, Cresko J. Energy efficiency as a foundational technology pillar for industrial decarbonization. Sustainability. 2023;15(12):9487.
8. Phadkantha R, Tansuchat R. Dynamic impacts of energy efficiency, economic growth, and renewable energy consumption on carbon emissions: Evidence from Markov Switching model. Energy Rep. 2023;9:332–6.
9. Rhouiri M, Meyabe MH, Benmoussa S, Bensouda M. Energy policy to overcome energy efficiency barriers: A literature review. Procedia Comput Sci. 2024;241:324–9.
10. Gökalp Y, Eti S. Investigating energy consumption in hospitals by text mining method. In: Dinçer H, Yüksel S, editors. Decision Making in Interdisciplinary Renewable Energy Projects: Navigating Energy Investments. Cham: Springer Nature Switzerland; 2024. p. 259–69.
11. Liu X, Zhang J, Qin B, Wang H, Zhu T, Ye Q. Research on the knowledge demands of multiple subjects for energy efficiency improvement in Chinese public buildings. Energy Build. 2023;300:113611.
12. Zhang QY, Best R, Chareunsy A. The impact of globalisation and education in promoting policies for renewables and energy efficiency. J Clean Prod. 2023;421:138559.
13. Fang F, Li K. Are higher-educated employees more responsible? A study about employee quality and corporate environmental sustainability. Sustainability. 2024;16(11):4624.
14. Alkandi IG, Khan MA, Fallatah M, Alabdulhadi A, Alanizan S, Alharbi J. The impact of incentive and reward systems on employee performance in the Saudi primary, secondary, and tertiary industrial sectors: A mediating influence of employee job satisfaction. Sustainability. 2023;15(4):3415.
15. Kwon G, Kim B, Kwon NK. Reinforcement learning with task decomposition and task-specific reward system for automation of high-level tasks. Biomimetics. 2024;9(4):196.
16. Marrucci L, Daddi T, Iraldo F. "Creating environmental performance indicators to assess corporate sustainability and reward employees." Ecological Indicators, 2024: 111489.
17. Mungai EM, Ndiritu SW, Rajwani T. The motivation for corporate energy strategies on energy efficiency among Kenyan firms. Corp Gov Int J Bus Soc. 2023;23(2):367–96.
18. Karras J. EU regulative framework. In: Legal barriers to the energy modernisation of dwellings occupied by low-income tenants and opportunities to overcome these barriers: Case study of Germany. Wiesbaden: Springer Fachmedien Wiesbaden; 2024. p. 59–98.
19. Edziah BK, Opoku EEO. Enhancing energy efficiency in Asia-Pacific: Comprehensive energy policy analysis. Energy Econ. 2024;138:107831.
20. He W, Wang B. Environmental jurisdiction and energy efficiency: Evidence from China's establishment of environmental courts. Energy Econ. 2024;131:107358.
21. Yasmeen R, Zhang X, Tao R, Shah WUH. The impact of green technology, environmental tax and natural resources on energy efficiency and productivity: Perspective of OECD Rule of Law. Energy Rep. 2023;9:1308–19.
22. Puška A, Nedeljković M, Pamučar D, Božanić D, Simić V. Application of the new simple weight calculation (SIWEC) method in the case study in the sales channels of agricultural products. MethodsX. 2024;13:102930.
23. Gökalp Y, Yüksel S, Dinçer H. Balanced scorecard-based cost analysis of service industry using a novel hybrid decision making approach based on golden cut-oriented bipolar and q-ROF sets. J Intell Fuzzy Syst. 2022;43(4):4709–22.
24. Kotsopoulos D, Bardaki C, Papaioannou TG. Determinants of employees' personal and collective energy consumption and conservation at work. Sustainability. 2023;15(6):4913.

APPENDICES

APPENDIX TABLE 1: THE IDENTIFIED STRATEGIES

Definitions	Codes
Creating energy saving awareness	ENGSVAW
Effective use of medical devices	EFFUSE
Reward programs	RWDPRG
Use of smart technologies	SMRTECH
Energy efficiency policy of the institution	ENGEFFPL
Legal processes	LGLPRCS

APPENDIX TABLE 2: THE DEFUZZIFIED VALUES

	ENGSVAW	EFFUSE	RWDPRG	SMRTECH	ENGEFFPL	LGLPRCS
Expert1	.998	.887	.998	.932	.708	.524
Expert2	.887	.887	.932	.932	.794	.524
Expert3	.932	.794	.932	.887	.794	.485
Expert4	.887	.794	.794	.887	.708	.580
Expert5	.887	.708	.932	.794	.580	.524

APPENDIX TABLE 3: THE NORMALIZED CRITERIA ASSESSMENT MATRIX

	ENGSVAW	EFFUSE	RWDPRG	SMRTECH	ENGEFFPL	LGLPRCS
Expert1	.217	.218	.218	.210	.198	.199
Expert2	.193	.218	.203	.210	.221	.199
Expert3	.203	.195	.203	.200	.221	.184
Expert4	.193	.195	.173	.200	.198	.220
Expert5	.193	.174	.203	.179	.162	.199

APPENDIX TABLE 4: THE MAXIMUM, MINIMUM AND DIFFERENCE VALUES

	ENGSVAW	EFFUSE	RWDPRG	SMRTECH	ENGEFFPL	LGLPRCS
Max	0,052	0,052	0,052	0,050	0,047	0,047
Min	0,028	0,029	0,025	0,029	0,029	0,032
Dif.	0,023	0,023	0,026	0,020	0,018	0,015