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Balanced Scorecard-Based Evaluation of Sustainable Energy Investment Projects with IT2 Fuzzy Hybrid Decision Making Approach

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Abstract: The purpose of this study is to determine the issues that financial institutions should pay attention to in their decision to provide financing to large scale energy projects. Within this framework, taking into account the Balanced Scorecard (BSC) approach, 4 dimensions and 8 criteria that can be effective in these decisions of financial institutions were determined. After that, the importance weights of these dimensions and criteria were determined by interval type-2 (IT2) fuzzy DEMATEL method. In addition, 3 different types of banks (public, private, foreign) are listed for their performance in financing energy projects. According to the results of the analysis, the technological and financial adequacy of the company that will invest in energy is the issue that financial institutions should pay the most attention to in their credit decision. Therefore, it is important for financial institutions to visit the customer's location and pay attention to the technological adequacy in the process of evaluating the customer's demand for credit for a large-scale energy project. In addition, it would be appropriate not to provide this fund to the energy companies with high indebtedness and insufficient liquidity. Another result of the study is that state banks have the lowest performance in financing these large-scale energy projects. When this result is taken into consideration, state banks need to pay more attention in evaluating large-scale energy projects in order to avoid major losses.

Keywords: energy finance; sustainability; Balanced Scorecard; IT2 Fuzzy DEMATEL; IT2 Fuzzy QUALIFLEX

1. Introduction

Energy is required in almost every aspect of human life. For example, in the fields of heating, cooling and transport, there is a serious need for energy. In addition to this, energy is also important for the development of industry. In other words, energy constitutes an important input item for industrial production. Because of this need, energy has also been a source of interest for investors. Many investors, who want to benefit from this great customer potential, want to increase their investments in the field of energy. Some of these investors focus on renewable energy sources such as oil and natural gas. In addition, especially in recent years, a number of investors have invested in renewable energy sources such as wind, solar and geothermal energy [1,2].

Investments in both renewable and non-renewable energy sources are very large projects. Therefore, having appropriate energy investments can contribute economic development of the countries by supporting industrial development and creating job opportunities. However, these investments involve high costs. Because of this situation, companies that want to invest in energy projects need significant funding [3,4]. The high cost and the long return period of energy projects cause financial institutions to hesitate in giving credit to them. The main reason for this is the high risk of non-repayment of these loans by energy companies due to these critical factors. Hence, financial institutions take many factors at the same time in their decision to finance these projects [5].

One of the factors affecting financial institutions' decision to lend to large-scale energy projects is the performance-oriented issues of the project. In this context, the total cost of the energy project and the return on investment period play an important role for financial institutions. In addition to the aforementioned factors, the reputation of the loan requesting company is also very important [6]. In this context, both the payment performance of the company requesting credit and its image in the market are important for the financing decision of financial institutions [7].

However, the company that will invest in the field of energy must be effective both technologically and organizationally. Energy investments are large-scale projects that require technical skills. Therefore, it is unlikely that the company, whose technological infrastructure is inadequate, can succeed in this project [8–10]. On the other hand, since these projects are also long-term, inter-departmental communication must be effective for the company to be successful. In addition to the criteria mentioned, the financial adequacy of the firm is an important factor in the credit decision of financial institutions. It is very difficult for companies with high indebtedness and liquidity risk to successfully complete their energy projects. On the other hand, since the risky market will also affect energy investments negatively, it is effective in the credit decisions of financial institutions [11].

As can be seen from the aforementioned issues, many different issues affect the decision of financial institutions to provide financing for energy projects. The critical point here is which factors or factors most financial institutions should pay attention to. Because these projects are both long-term and highly costly, a wrong decision can cause serious damage to financial institutions. Another issue that should be taken into consideration in this process is identifying the criteria. In this context, Balanced Scorecard (BSC) approach is frequently preferred in the literature. This method is considered to be successful because it considers both financial and non-financial aspects [12].

In this process, the determination of the importance of the criteria is as important as the selection of the criteria. In this context, multi-criteria decision-making methods are frequently preferred in the literature in order to reach a certain purpose [13,14]. These methods are used to identify the more important ones when there are many different criteria. It is also seen that these methods are taken into consideration by fuzzy logic approach in the literature. This situation makes it easier to find solutions to uncertain and complex issues. On the other hand, since this approach is based on expert opinions, it is possible to obtain more realistic results in the analysis.

In this study, the issues that banks should pay attention to when making decisions to extend loans to large-scale energy investments are investigated. In this context, similar studies in the literature have been examined and 4 dimensions and 8 different criteria have been identified based on BSC approach. These factors have been identified specifically for the financing process of large-scale energy projects only. Subsequently, the mentioned dimensions and criteria were weighted according to their significance with the IT2 fuzzy DEMATEL method. Hence, it can be possible to understand which items are more important to evaluate the financing energy projects. In the last stage of the analysis, considering these weighted factors, 3 different bank types (state, private, foreign) were ranked. In this process, IT2 fuzzy QUALIFLEX method was considered. Thus, it can be determined which bank type is more successful in financing energy projects. With the help of these results, necessary recommendations can be presented to increase the performance of energy projects.

In recent years, the energy sector has been one of the sectors in which domestic and foreign investors have shown the most interest. It is also vital that countries focus on financing investments in this strategic sector. Therefore, financing energy projects is important for the sustainable development of the country. Hence, the most important contribution of the study is the focus on financing large-scale energy projects. In this context, the research question of the study is what the financial institutions should pay attention to in order not to fail large-scale energy financing. Otherwise, these projects will not support the country's energy supply process and will cause serious damage to financial institutions.

It is possible to mention some specific aspects of this study. First of all, a weighted set of criteria that can be taken into account in the decision whether or not to give credit to energy projects is created. These factors guide financial institutions who want to lend to energy projects. In addition, the IT2 fuzzy DEMATEL and IT2 fuzzy QUALIFLEX approach are used for the first time in the subject of financing energy projects. This issue is thought to increase the originality of the study. In addition, it will be possible to create an impact-relation map and to rank a small number of alternatives according to their importance with the help of using these two approaches. On the other hand, uncertainties in this complex environment can be reduced by using type 2 fuzzy logic. Furthermore, by identifying criteria based on BSC dimensions, both financial and nonfinancial factors are considered. Thus, more appropriate criteria set can be generated for this purpose. The final novelty of the company is that a comparative analysis can be made to see which bank types are more successful in financing decision of the energy projects.

There are 5 different sections in this study. This section is the first part of the study and in this context, general information about the subject is shared. In the second part of the study, literature review is made. Within this framework, first of all, the studies conducted for the financing of large-scaled projects are examined. Then, some studies using BSC and fuzzy multi criteria decision making methods are explained. In the third part of the study, theoretical information about the IT2 fuzzy DEMATEL and IT2 fuzzy QUALIFLEX methods which are taken into consideration in the analysis process are shared. The details of the analysis are given in the fourth part of the study. In the last section, the analysis results and recommendations are explained.

2. Literature Review

This part consists of three different subsections. In the first aspect, some studies related to the financing large-scaled projects are shared. Secondly, studies in which BSC approach was considered are explained. In the final part, there is literature review related to the fuzzy multi-criteria decision-making models.

2.1. Literature Review on the Financing of Large-Scaled Projects

The financing of large projects has been examined in many studies in the literature. In a very important dimension of the studies, it was tried to determine which factors institutions pay attention in making funding decision of these projects. According to some researchers, the most important factor in the financing decision of large projects is the cost of the project. For example, Mora et al. [15] stated that if the investment is too high, this credit should not be granted. In parallel with the work described, Dell et al. [16] also investigated which factors are significant when funding funds for large-scale electricity investment projects. In this study, it is concluded that the cost of the project is the most important factor affecting this decision. Srivastava [17] conducted a similar study for India. It is identified that having high expenditure can cause a failing project, so it should be taken into consideration. Furthermore, Ogino [18] and Oinarov et al. [19] focused on South Asia and Kazakhstan by using regression methodology for this purpose. They determined that having high costs increases the risk of failure.

In some studies, the most important issue to be considered in the financing decisions of large-scale projects is the financial position of the company. For example, Cruz and Sarmento [20] stated that companies with very high indebtedness will have difficulty managing this process, even if the project is profitable. This will result in the failure of the project. On the other hand, Moore [21] made an analysis for Australia, US and Europe and concluded that companies that cannot manage their own liquidity will not be able to sustain this situation for long. As a result, the success of the projects will be difficult. Similarly, Cooper and Nyborg [22] identified that the fact that companies are exposed to too much liquidity risk increases the probability that the project will fail. In addition to these studies, Montgomery et al. [23], Sainati et al. [24] and Rode et al. [25] focused on this issue for different countries, such as UK, Turkey, Indonesia, Malaysia and Brazil. They defined that technical and organizational effectiveness of the company is the most significant factor to make funding decisions of large-scale projects. On the other side, Subramanian and Tung [26], Mann and Howe [27] and Parra and Polanía [28] underlined that growth potential of the market is a very significant aspect while making financing decision of the large scaled projects.

According to many researchers, the credibility of the firm is also very important in financial institutions' decision to lend for large-scale projects. In some of these studies, it is emphasized that financial reputation is very important in this decision. Financial reputation refers to the credibility of the firm in its relations with financial institutions [29]. For example, if firms have unpaid checks or notes, it is possible to determine this from financial records. In other words, financial reputation describes the firm's credibility that can be determined from official records [26]. On the other hand, some researchers have emphasized that financial reputation will not be sufficient in the lending decision of large-scale projects. These people argue that the perception of the firm in the market, which is also named as market reputation, should be learned when evaluating large-scale projects [30]. For example, Ahiabor and James [31] conducted a review of European countries and emphasized that market reputation is more important in such cases. Similarly, Pacudan [32] and Hamman [33] conducted an analysis on different countries and concluded that the firm's market reputation would be more realistic than the official records.

The return on investment period has been emphasized in many studies as the issue to be considered in financing decisions of large-scale projects. Therefore, the period of transition of these investments to profitability can be very long [34,35]. Therefore, it is not easy for companies to deal with high costs in this long period. Within the given time period, some companies whose financial situation is not very strong may go bankrupt [36–38]. Therefore, some researchers have argued that financial institutions should definitely pay attention to the return on investment period in the financing decisions of large-scale projects [39–41]. For example, Steffen [42] and Thierie and Moor [43] conducted studies for European countries. In these studies using regression method, it is stated that the most important issue is the return on investment period.

Another issue that stands out in the results of the studies examining the financing decisions of the projects to a large extent is market risk. In its shortest definition, market risk is the possibility of loss of firms due to price movements in the market [44]. For example, if the foreign exchange rate is overvalued, firms with high foreign exchange debt may suffer too much loss. Therefore, it is accepted that these firms with high foreign exchange debt have market risk [45]. In this context, Jong and Park [46] conducted a study considering the Monte Carlo simulation technique for Korea. According to the results of the analysis, they stated that it is risky to lend large-scale projects of firms with high FX indebtedness. De Marco and Mangano [47], on the other hand, argued that in this decision stage, the riskiness of the country in which the company operates is considered. According to Choi and Kim [48], financing decisions of large-scale projects are very risky in a market where oil prices are volatile. In addition, Ma [49] and Park [50] also stated that large-scale financing should not be provided to firms that do not perform effective risk management.

With respect to the financing decision of large-scale energy projects, there are also some studies in the literature. It is seen that a significant part of the studies is carried out for the financing of renewable energies. Since renewable energy is an inexhaustible type of energy, it attracts the attention of investors [51]. However, because these projects are very costly, it is very difficult to find financing [52]. Within this framework, Yoshino and Taghizadeh-Hesary [53] argued that energy taxation is an important issue to find necessary financial sources of energy projects. Similar to this situation, Ng and Tao [54] stated that bond financing is a significant way of reaching financial sources for large-scale renewable energy projects. In addition to them, Hall et al. [6], Laureti et al. [55] and Yoshino and Taghizadeh-Hesary [56] made an analysis to make investment in low-carbon transitions.

On the other side, Gallagher et al. [57] and Lee and Zhong [58] focused on the financial risk management of the energy projects.

2.2. Literature Review on Balance Scorecard Approach

The BSC methodology is an approach that helps companies to more effectively execute strategies to achieve their goals. The method was developed by Kaplan and Norton [12]. At that time financial strategies were often developed for companies. However, these authors argued that financial strategies alone could not be sufficient to achieve the goals of the companies. Therefore, the developed BSC approach includes 4 different dimensions: finance, customer, internal processes and learning development. In other words, in addition to financial issues, 3 different factors were taken into consideration in the BSC approach. Since both financial and non-financial aspects are included in the review, the word balanced is used in the name of this method [8].

In the financial aspect of the BSC approach, issues such as profitability of the company, income level and effective cost management are taken into consideration. In addition, the customer dimension includes factors that can increase customer satisfaction, such as the fulfillment of customer expectations and the management of customer complaints. On the other hand, factors such as the effectiveness of interdepartmental communication and the technological infrastructure of the company are handled in the internal processes dimension of BSC. Finally, the training and development dimension is related to the quality of the personnel of the company and the training received [59].

The BSC method is a very popular approach in the literature. This method has been considered by many researchers for different sectors. For example, Dimitropoulos et al. [60], Yao and Liu [61] and Ndevu and Muller [62] used this method to assess the effectiveness of governments. Similarly, Ge [63] and Wang et al. [64] focused on how to improve the performance of local governments by taking BSC method into consideration. Ćwiklicki [65] conducted this study for non-profit organizations. On the other hand, Elkhouty et al. [66], Sardjono and Pujadi [67] and Dinçer and Yüksel [68] used the dimensions of the BSC approach when evaluating the performance of banks. In addition, Dong et al. [69], Dinçer et al. [70], Kahla [71] and Dinçer and Yüksel [72] have also determined the criteria according to BSC approach while analyzing energy companies.

2.3. Literature Review on Fuzzy Multi-Criteria Decision-Making Methods

Multi-criteria decision-making methods are mainly used to make decision when there are lots of criteria and alternatives. In the literature, these approaches are also considered with fuzzy logic in order to reach the solution under the complex environment. It is possible to categorize these approaches into two different classes. The first category is related to the approaches which are used to weight different criteria. For instance, Chou et al. [73], Singh and Prasher [74] and Yıldız and Kahraman [75] used fuzzy AHP methodology for different purposes, such as the effectiveness of Human Resources departments and healthcare service quality. Moreover, Alilou et al. [76] and Kılıç and Kabak [77] considered fuzzy ANP methodology to make analysis for human development and environmental issues. Therefore, inner dependency among the criteria can be handled in these studies. On the other side, Lo et al. [78], Wang et al. [79] and Goyal et al. [80] considered fuzzy DEMATEL to weight the criteria for the selection of recycling partner, e-commerce performance and measuring environmental sustainability. With the help of fuzzy DEMATEL approach, impact relation map can be created in these studies. In the recent studies, it can be seen that fuzzy DEMATEL methodology is implemented with interval type-2 fuzzy logic [81–83].

The second purpose of these multi-criteria decision-making models is ranking different alternatives. In this context, some weighted criteria are taken into consideration. For example, Chou et al. [73], Cavallaro et al. [9] and Mohsin et al. [84] used fuzzy TOPSIS method for different purposes, such as measuring technological performance and analyzing energy effectiveness. Furthermore, fuzzy VIKOR methodology was also considered by Liang et al. [85], Tian et al. [14] and Gul et al. [86] mainly with the aim of evaluating internet banking website quality, selection of reverse logistic partners and risk assessment in mine industry. On the other hand, Arabsheybani et al. [87], Khan et al. [13] and Gürbüz and Erdinç [88] focused on sustainable supplier selection, identifying the optimal combination for pure titanium and determining the best hotel by using fuzzy MOORA. With the help of this approach, both positive and negative criteria can be taken into consideration in these studies. Moreover, Demirel et al. [89], Dong et al. [90] and Liang et al. [91] tried to rank different alternatives with fuzzy QUALIFLEX. Ranking a small number of alternatives according to their importance is not easy with fuzzy multi-criteria decision-making methods. However, it is possible to make such an analysis with the help of the fuzzy QUALIFLEX method. This approach is also considered with interval type-2 fuzzy logic, but the number of these studies is very limited [92,93].

As a result of the literature review, it has been determined that there are many studies on financing decisions of large-scale projects. It is seen that a limited number of these studies focus on energy projects. In these studies that analyze the energy sector, the issue of where this finance will be obtained rather than the financial decisions is examined. Therefore, it is seen that there is a need for a new study on what affects the financing decisions of large-scale energy projects. Furthermore, it is understood that fuzzy logic method has not been considered in this context before. In this study, IT2 fuzzy DEMATEL and IT2 fuzzy QUALIFLEX methods are taken into consideration what affects the financing decisions of large-scale energy projects. Hence, it is believed that this study completes this issue which is thought to be incomplete in the literature.

3. Methodology

In this study, two different fuzzy multi-criteria decision-making methods are considered which are IT2 fuzzy DEMATEL and IT2 fuzzy QUALIFLEX. The theoretical information of these approaches is detailed in the following subsections.

3.1. IT2 Fuzzy DEMATEL

DEMATEL (decision making trial and evaluation laboratory) methodology is mainly used to understand the significance levels of the criteria. In addition, it is also possible to see impact relation map by using this approach. Hence, it is very helpful to understand the causality relationship among different items. DEMATEL approach can be extended with IT2 fuzzy sets. The evaluations of the decision makers are provided in the first aspect. After that, they are converted to the fuzzy sets. Secondly, with the help of these evaluations, initial direct relation matrix ($\widetilde{Z}$) is generated. Equation (1) explains the details of this matrix.

$$\widetilde{Z}=\begin{bmatrix} 0 & \widetilde{z}_{12} & \cdots & \cdots & \widetilde{z}_{1n} \\ \widetilde{z}_{21} & 0 & \cdots & \cdots & \widetilde{z}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{z}_{n1} & \widetilde{z}_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{1}$$

Average fuzzy scores are used to obtain this matrix. This process is also explained in the Equation (2).

$$\widetilde{Z} = \frac{\widetilde{Z}^1 + \widetilde{Z}^2 + \widetilde{Z}^3 + \ldots \widetilde{Z}^n}{n} \tag{2}$$

Normalization process is performed in the third step and this normalized matrix is obtained with the help of the Equations (3)–(5).

$$\widetilde{X} = \begin{bmatrix} \widetilde{x}_{11} & \widetilde{x}_{12} & \cdots & \cdots & \widetilde{x}_{1n} \\ \widetilde{x}_{21} & \widetilde{x}_{22} & \cdots & \cdots & \widetilde{x}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{x}_{n1} & \widetilde{x}_{n2} & \cdots & \cdots & \widetilde{x}_{nn} \end{bmatrix} \quad (3)$$

$$\widetilde{x}_{ij} = \frac{\widetilde{z}_{ij}}{r} = \left(\left(\frac{Z_{\acute{a}_{ij}}}{r}, \frac{Z_{\acute{b}_{ij}}}{r}, \frac{Z_{\acute{c}_{ij}}}{r}, \frac{Z_{\acute{d}_{ij}}}{r}; H_1\left(z^U_{ij}\right), H_2\left(z^U_{ij}\right)\right), \left(\frac{Z_{\acute{e}_{ij}}}{r}, \frac{Z_{\acute{f}_{ij}}}{r}, \frac{Z_{\acute{g}_{ij}}}{r}, \frac{Z_{\acute{h}_{ij}}}{r}; H_1\left(z^L_{ij}\right), H_2\left(z^L_{ij}\right)\right)\right) \quad (4)$$

$$r = max\left(max_{1 \le i \le n} \sum_{j=1}^{n} Z_{\acute{d}_{ij}}, max_{1 \le i \le n} \sum_{j=1}^{n} Z_{\acute{d}_{ij}}\right) \quad (5)$$

Total influence fuzzy matrix ($\widetilde{T}$) is created in the fourth step. For this purpose, Equations (6)–(10) are taken into consideration.

$$X_{\acute{a}} = \begin{bmatrix} 0 & a'_{12} & \cdots & \cdots & a'_{1n} \\ a'_{21} & 0 & \cdots & \cdots & a'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a'_{n1} & a'_{n2} & \cdots & \cdots & 0 \end{bmatrix}, \ldots, X_{\acute{h}} = \begin{bmatrix} 0 & h'_{12} & \cdots & \cdots & h'_{1n} \\ h'_{21} & 0 & \cdots & \cdots & h'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ h'_{n1} & h'_{n2} & \cdots & \cdots & 0 \end{bmatrix} \quad (6)$$

$$\widetilde{T} = \lim_{k \to \infty} \widetilde{X} + \widetilde{X}^2 + \ldots + \widetilde{X}^k \quad (7)$$

$$\widetilde{T} = \begin{bmatrix} \widetilde{t}_{11} & \widetilde{t}_{12} & \cdots & \cdots & \widetilde{t}_{1n} \\ \widetilde{t}_{21} & \widetilde{t}_{22} & \cdots & \cdots & \widetilde{t}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{t}_{n1} & \widetilde{t}_{n2} & \cdots & \cdots & \widetilde{t}_{nn} \end{bmatrix} \quad (8)$$

$$\widetilde{t}_{ij} = \left(a''_{ij}, b''_{ij}, c''_{ij}, d''_{ij}; H_1\left(\widetilde{t}_{ij}{}^U\right), H_2\left(\widetilde{t}_{ij}{}^U\right)\right), \left(e''_{ij}, f''_{ij}, g''_{ij}, h''_{ij}; H_1\left(\widetilde{t}_{ij}{}^L\right), H_2\left(\widetilde{t}_{ij}{}^L\right)\right) \quad (9)$$

$$\left[a''_{ij}\right] = X_{\acute{a}} \times (I - X_{\acute{a}})^{-1}, \ldots, \left[h''_{ij}\right] = X_{\acute{h}} \times \left(I - X_{\acute{h}}\right)^{-1} \quad (10)$$

Consequently, the influence degrees are computed in the final step. In this scope, the sums of all vector rows ($\widetilde{D}_i$) and columns ($\widetilde{R}_i$) of the total relation matrix are used. Equations (11) and (12) explain this situation.

$$\widetilde{D}_i = \left[\sum_{j=1}^{n} \widetilde{t}_{ij}\right]_{n \times 1} \quad (11)$$

$$\widetilde{R}_i = \left[\sum_{i=1}^{n} \widetilde{t}_{ij}\right]'_{1 \times n} \quad (12)$$

In this equation, $\left(\widetilde{D}_i + \widetilde{R}_i\right)$ indicates the total degree of the influence among the issues. In case of the fact that this value is higher, it demonstrates that the criterion will be closer to the central point.

3.2. IT2 Fuzzy QUALIFLEX

The QUALIFLEX is a type of multi-criteria decision-making method which mainly aims to rank different alternatives. The main advantage of this approach is to provide flexibility with the correct treatment of cardinal and ordinal information. Another important issue is that it can be possible to make analysis with small number of alternatives. The details of QUALIFLEX method based on IT2 fuzzy logic are summarized in 4 different steps. The first step is related to the development of the decision matrix which is stated in the Equations (13) and (14).

$$\begin{array}{cc} & \begin{array}{cccccc} X1 & X2 & X3 & \dots & & Xn \end{array} \\ D = \begin{array}{c} A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_m \end{array} & \begin{bmatrix} A_{11} & A_{12} & A_{13} & & \cdots & A_{1n} \\ A_{21} & A_{22} & A_{23} & & \cdots & A_{2n} \\ A_{31} & A_{32} & A_{33} & & \cdots & A_{3n} \\ \vdots & \vdots & \vdots & \ddots & & \vdots \\ A_{m1} & A_{m2} & A_{m3} & & \cdots & A_{mn} \end{bmatrix} \end{array} \tag{13}$$

$$A_{ij} = \frac{1}{k}\left[\sum_{e=1}^{k} A_{ij}{}^{e}\right] \tag{14}$$

The second step is related to the calculation of the signed distance $d\left(A_{ij}, \widetilde{0}\right)$. In this framework, Equations (15) and (16) are considered.

$$d\left(A_{ij}, \widetilde{0}\right) = \frac{1}{8}\left(a_{1ij}^{L} + a_{2ij}^{L} + a_{3ij}^{L} + a_{4ij}^{L} + 4a_{1ij}^{U} + 2a_{2ij}^{U} + 2a_{3ij}^{U} + 4a_{4ij}^{U} + 3(a_{2ij}^{U} + a_{3ij}^{U} - a_{1ij}^{U} - a_{4ij}^{U})\frac{h_{ij}^{L}}{h_{ij}^{U}}\right) \tag{15}$$

$$A_{ij} = \left[A_{ij}^{L}, A_{ij}^{U}\right] = \left[\left(a_{1ij}^{L}, a_{2ij}^{L}, a_{3ij}^{L}, a_{4ij}^{L}; h_{ij}^{L}\right), \left(a_{1ij}^{U}, a_{2ij}^{U}, a_{3ij}^{U}, a_{4ij}^{U}; h_{ij}^{U}\right)\right] \tag{16}$$

In the third step, the concordance/discordance index (I_j^l) is computed with the help of the Equations (17)–(19).

$$I_j^l = \sum_{A_\rho, A_\beta \in A} I_j^l\left(A_\rho, A_\beta\right) = \sum_{A_\rho, A_\beta \in A} \left(d\left(A_{\rho j}, \widetilde{0}_1\right) - d\left(A_{\beta j}, \widetilde{0}_1\right)\right) \tag{17}$$

$$\begin{aligned} A_{\rho j} &= \left[A_{\rho j}^{L}, A_{\rho j}^{U}\right] = \left[\left(a_{1\rho j}^{L}, a_{2\rho j}^{L}, a_{3\rho j}^{L}, a_{4\rho j}^{L}; h_{\rho j}^{L}\right), \left(a_{1\rho j}^{U}, a_{2\rho j}^{U}, a_{3\rho j}^{U}, a_{4\rho j}^{U}; h_{\rho j}^{U}\right)\right] \\ A_{\beta j} &= \left[A_{\beta j}^{L}, A_{\beta j}^{U}\right] = \left[\left(a_{1\beta j}^{L}, a_{2\beta j}^{L}, a_{3\beta j}^{L}, a_{4\beta j}^{L}; h_{\beta j}^{L}\right), \left(a_{1\beta j}^{U}, a_{2\beta j}^{U}, a_{3\beta j}^{U}, a_{4\beta j}^{U}; h_{\beta j}^{U}\right)\right] \end{aligned} \tag{18}$$

$$P_l = \left(\dots, A_\rho, \dots, A_\beta \dots\right) \text{ for } l = 1, 2, \dots, m! \tag{19}$$

The final step is related to the development of the comprehensive concordance/discordance index. Equation (20) is used for this purpose.

$$I^l = \sum_{A_\rho, A_\beta \in A} \sum_{j=1}^{n} I_j^l\left(A_\rho, A_\beta\right).W_j = \sum_{A_\rho, A_\beta \in A} \sum_{j=1}^{n} \left(d\left(A_{\rho j}, \widetilde{0}_1\right) - d\left(A_{\beta j}, \widetilde{0}_1\right)\right).W_j \tag{20}$$

4. An Analysis on Energy Investment Projects

The analysis process has mainly 3 different stages. Firstly, the dimensions and criteria are identified. After that, these factors are weighted with the help of IT2 fuzzy DEMATEL. In the final stage, IT2 fuzzy QUALIFLEX is considered to rank the alternatives.

4.1. Identifying the Dimensions and Criteria

In the first stage of the analysis, the dimensions and criteria are defined with the help of the literature review. In this process, 4 different BSC perspectives are taken into consideration. Consequently, 4 project evaluation dimensions and 8 criteria are identified. In this framework, literature is reviewed specifically to the large-scale energy financing process. The details of them are given on Table 1.

Table 1. The Details of Dimensions and Criteria.

BSC Perspectives	Energy Project Evaluation Dimensions	Criteria	References
Finance	Project Performance	Investment Cost	Srivastava [17]; Oinarov et al. [19]
		Return on Investment	Mora et al. [15]; Dell et al. [16]
Customer	Corporate Reputation	Financial Reputation	Thierie and Moor [29]; Subramanian and Tung [26]
		Market Reputation	Ahiabor and James [31]; Pacudan [32]
Internal Process	Operational Effectiveness	Technical and Organizational Effectiveness	Rode et al. [25]; Montgomery et al. [23]
		Financial Effectiveness	Cruz and Sarmento [20]; Sainati et al. [24]
Learning and Growth	Competitive Structure	Growth Potential	Parra and Polanía [28]; Mann and Howe [27]
		Market Risks	Müllner [44]

In this framework, dimensions and criteria are selected based on BSC approach. This approach was used by many different researchers in the literature with various purposes. Because it consideres both financial and nonfinancial issues, it is accepted as an appropriate methodology. Therefore, BSC method is preferred in this study with the aim of identifying dimensions and criteria appropriately. Thus, it is aimed to minimize the risk of not considering an important factor regarding the financing decision of energy investment projects. With respect to the finance perspective of BSC approach, project performance is defined as the dimension. In this scope, firstly, investment cost is the first criterion because energy projects have high costs. Hence, this factor can be a leading indicator for the financial institutions to make financing decision. Another important criterion is return on investment which gives information about when this project can cover their high costs. Since energy investment projects can take too much time to finish, it contains some risks. Hence, return period of the investment and the cost amount should be taken into consideration together.

As for the customer perspective of BSC method, corporate reputation is used for the dimension. Under this dimension, two different criteria are identified which are financial reputation and market reputation. Financial reputation demonstrates the prior payment performance of the company with financial institutions. In other words, it indicates the credibility information of the company provided from the official records. On the other side, market reputation gives information about the credibility of the company on the eyes of the customers, employees and suppliers.

Regarding the internal process perspective of BSC approach, operational effectiveness of the company is considered as the dimension. In this framework, technical and operational effectiveness of the company is an important criterion for the financing decision of the financial institutions. Because energy projects are very complex investments, they need technological infrastructure. Therefore, for the companies, which do not have effective technological capacity, it is very difficult to be successful in these projects. Similarly, effective communication between the departments of the company is also a must for this success. The second criterion of this dimension is defined as the financial capacity. It gives information that there is a significant risk for the success of the company in the energy projects if they have high debt and liquidity problems.

For the learning and growth perspective of BSC model, competitive structure is determined as the dimension. Additionally, two different criteria are selected for this dimension that are growth potential and market risk. If the market has a significant demand for the energy, it means that the company can get important amount of income from this energy project. Because it increases the success probability of the energy projects, it affects the financing decision of the financial institution for this project positively. On the other side, market risk gives information about the volatility of the prices in the market. For instance, volatility in currency exchange rate and interest rate indicates the risks in the market. In such a volatile environment, financial institutions become unwilling to give credit to the large-scaled energy projects.

After identifying dimensions and criteria, their significance levels are identified with IT2 fuzzy DEMATEL approach. After that, the performance of state, private and foreign banks is ranked by using IT2 fuzzy QUALIFLEX. For this purpose, 3 decision makers are appointed to provide their linguistic evaluations. The expert team evaluating the dimensions and criteria is composed of academician and senior managers in Energy Company as well as banking industry with at least 15-year experience. One of them is an academician and has also an experience in the field of energy industry and the others are banking experts and have experiences in the state-owned, private and foreign banks respectively and work in the field of investment and development banking.

Questions related to 4 dimensions and 8 criteria determined for energy investment projects were prepared. The question sets presented to the evaluation of the experts were prepared in two different sets for dimensions and criteria separately. In these question sets, dimensions and criteria were compared among themselves. In other words, experts were asked to compare the dimensions and criteria among themselves. In this process, linguistic choices for criteria and alternatives are considered which have 9 different scales. The details of them are demonstrated on Table 2.

Table 2. Linguistic Choices for Criteria and Alternatives.

Criteria	Alternatives	IT2TrFNs
Absolutely Low (AL)	Absolutely Poor (AP)	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))
Very Low (VL)	Very Poor (VP)	((0.0075, 0.0075, 0.015, 0.0525; 0.8), (0.0, 0.0, 0.02, 0.07; 1.0))
Low (L)	Poor (P)	((0.0875, 0.12, 0.16, 0.1825; 0.8), (0.04, 0.10, 0.18, 0.23; 1.0))
Medium Low (ML)	Medium Poor (MP)	((0.2325, 0.255, 0.325, 0.3575; 0.8), (0.17, 0.22, 0.36, 0.42; 1.0))
Medium (M)	Fair (F)	((0.4025, 0.4525, 0.5375, 0.5675; 0.8), (0.32, 0.41, 0.58, 0.65; 1.0))
Medium High (MH)	Medium Good (MG)	((0.65, 0.6725, 0.7575, 0.79; 0.8), (0.58, 0.63, 0.80, 0.86; 1.0))
High (H)	Good (G)	((0.7825, 0.815, 0.885, 0.9075; 0.8), (0.72, 0.78, 0.92, 0.97; 1.0))
Very High (VH)	Very Good (VG)	((0.9475, 0.985, 0.9925, 0.9925; 0.8), (0.93, 0.98, 1.0, 1.0; 1.0))
Absolutely High (AH)	Absolutely Good (AG)	((1.0, 1.0, 1.0, 1.0; 1.0), (1.0, 1.0, 1.0, 1.0; 1.0))

Source: Chen et al. [94].

Table 3 represents the linguistic evaluations of these decision makers for 8 different criteria.

Table 3. Linguistic Evaluations of Decision Makers for Criteria.

	C1			**C2**			**C3**			**C4**		
	DM1	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**
C1	-	-	-	H	H	M	M	M	ML	M	M	M
C2	M	M	ML	-	-	-	M	M	ML	M	M	M
C3	M	M	MH	ML	M	M	-	-	-	L	ML	L
C4	MH	M	ML	M	L	ML	ML	M	ML	-	-	-
C5	VH	H	VH	H	H	VH	H	VH	H	VH	MH	AH
C6	M	ML	H	H	H	MH	H	H	MH	H	M	H
C7	MH	MH	H	MH	M	M	ML	ML	M	VL	M	M
C8	M	MH	M	MH	M	MH	M	M	ML	M	M	MH
	C5			C6			C7			C8		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
C1	ML	ML	L	ML	M	M	ML	ML	L	M	ML	M
C2	ML	ML	VL	M	ML	ML	ML	ML	M	M	M	M
C3	M	ML	VL	M	ML	M	L	ML	ML	L	VL	M
C4	ML	M	ML	ML	M	M	VH	M	M	M	ML	M
C5	-	-	-	H	VH	VH	AH	VH	VH	VH	VH	H
C6	VL	M	ML	-	-	-	MH	H	MH	MH	H	H
C7	VL	M	L	ML	M	M	-	-	-	M	M	M
C8	ML	M	L	M	ML	ML	ML	ML	M	-	-	-

On the other side, decision makers' evaluations for 3 different alternatives are given on Table 4. In this context, both Table 3 and 4 demonstrate the input data used in the analysis.

Table 4. Linguistic Evaluations of Decision Makers for Alternatives.

Criteria/Alternatives	**State-Owned Banks (Alternative 1)**			**Private Banks (Alternative 2)**			**Foreign Banks (Alternative 3)**		
	DM1	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**
Investment Cost (Criterion 1)	G	G	VG	G	G	G	G	G	G
Return on Investment (Criterion 2)	MG	F	G	G	VG	AG	G	VG	G
Financial Reputation (Criterion 3)	F	MG	MG	G	VG	G	VG	G	VG
Market Reputation (Criterion 4)	MG	MG	MG	VG	VG	G	VG	G	VG
Technical and Organizational Effectiveness (Criterion 5)	F	G	MG	VG	VG	AG	G	G	AG
Financial Effectiveness (Criterion 6)	G	G	MG	G	VG	G	G	G	VG
Growth Potential (Criterion 7)	VG	G	VG	VG	VG	G	G	G	G
Market Risks (Criterion 8)	F	G	F	G	MG	VG	G	MG	G

4.2. Weighting the Dimensions and Criteria

In the second stage of the analysis, these dimensions and criteria are weighted and IT2 fuzzy DEMATEL method is taken into consideration. In the first aspect, direct relation matrix is created that is given on Table 5.

Table 5. Direct-relation matrix.

	C1	C2	C3	C4
C1	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.66, 0.69, 0.72, 0.90; 0.80), (0.59, 0.66, 0.81, 0.86; 1.00))	((0.35, 0.39, 0.47, 0.50; 0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.40, 0.45, 0.54, 0.57; 0.80), (0.32, 0.41, 0.58, 0.65; 1.00))
C2	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.40, 0.45, 0.54, 0.57;0.80), (0.32, 0.41, 0.58, 0.65; 1.00))
C3	((0.49, 0.53, 0.61, 0.64;0.80), (0.41, 0.48, 0.65, 0.72; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.14, 0.17, 0.22, 0.24; 0.80), (0.08, 0.14, 0.24, 0.29; 1.00))
C4	((0.43, 0.46, 0.54, 0.57;0.80), (0.36, 0.42, 0.58, 0.64; 1.00))	((0.24, 0.28, 0.34, 0.37;0.80), (0.18, 0.24, 0.37, 0.43; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))
C5	((0.89, 0.93, 0.96, 0.96; 0.80), (0.86, 0.91, 0.97, 0.99; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))	((0.87, 0.89, 0.92, 0.93;0.80), (0.84, 0.87, 0.93, 0.95; 1.00))
C6	((0.47, 0.51, 0.58, 0.61; 0.80), (0.40, 0.47, 0.61, 0.68; 1.00))	((0.74, 0.77, 0.84, 0.87;0.80), (0.67, 0.73, 0.88, 0.93; 1.00))	((0.74, 0.77, 0.84, 0.87;0.80), (0.67, 0.73, 0.88, 0.93; 1.00))	((0.66, 0.69, 0.72, 0.90;0.80), (0.59, 0.66, 0.81, 0.86; 1.00))
C7	((0.69, 0.72, 0.80, 0.83;0.80), (0.63, 0.68, 0.84, 0.90;1.00))	((0.49, 0.53, 0.61, 0.64;0.80), (0.41, 0.48, 0.65, 0.72; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.27, 0.30, 0.36, 0.40;0.80), (0.21, 0.27, 0.39, 0.46; 1.00))
C8	((0.49, 0.53, 0.61, 0.64;0.80), (0.41, 0.48, 0.65, 0.72; 1.00))	((0.57, 0.60, 0.68, 0.72;0.80), (0.49, 0.56, 0.73, 0.79; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.49, 0.53, 0.61, 0.64;0.80), (0.41, 0.48, 0.65, 0.72; 1.00))
	C5	C6	C7	C8
C1	((0.18, 0.21, 0.27, 0.30;0.80), (0.13, 0.18, 0.30, 0.36; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.18, 0.21, 0.27, 0.30;0.80), (0.13, 0.18, 0.30, 0.36; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))
C2	((0.16, 0.17, 0.22, 0.26;0.80), (0.11, 0.15, 0.25, 0.30; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.40, 0.45, 0.54, 0.57;0.80), (0.32, 0.41, 0.58, 0.65; 1.00))
C3	((0.21, 0.24, 0.29, 0.33;0.80), (0.16, 0.21, 0.32, 0.38; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.18, 0.21, 0.27, 0.30;0.80), (0.13, 0.18, 0.30, 0.36; 1.00))	((0.17, 0.19, 0.24, 0.27;0.80), (0.12, 0.17, 0.26, 0.32; 1.00))
C4	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.58, 0.63, 0.69, 0.71;0.80), (0.52, 0.60, 0.72, 0.77; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))
C5	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.89, 0.93, 0.96, 0.96; 0.80), (0.86, 0.91, 0.97, 0.99; 1.00))	((0.97, 0.99,1.00,1.00;0.80), (0.95, 0.99,1.00,1.00; 1.00))	((0.89, 0.93, 0.96, 0.96; 0.80), (0.86, 0.91, 0.97, 0.99; 1.00))
C6	((0.21, 0.24, 0.29, 0.33;0.80), (0.16, 0.21, 0.32, 0.38; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.69, 0.72, 0.80, 0.83;0.80), (0.63, 0.68, 0.84, 0.90; 1.00))	((0.74, 0.77, 0.84, 0.87;0.80), (0.67, 0.73, 0.88, 0.93; 1.00))
C7	((0.17, 0.19, 0.24, 0.27;0.80), (0.12, 0.17, 0.26, 0.32; 1.00))	((0.35, 0.39, 0.47, 0.50;0.80), (0.27, 0.35, 0.51, 0.57; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))	((0.40, 0.45, 0.54, 0.57;0.80), (0.32, 0.41, 0.58, 0.65; 1.00))
C8	((0.24, 0.28, 0.34, 0.37;0.80), (0.18, 0.24, 0.37, 0.43; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.29, 0.32, 0.40, 0.43;0.80), (0.22, 0.28, 0.43, 0.50; 1.00))	((0.0, 0.0, 0.0, 0.0; 1.0), (0.0, 0.0, 0.0, 0.0; 1.0))

After that, the weights of the dimensions and criteria are calculated. The summary results are illustrated on Table 6.

Table 6. Weights of Criteria and Dimensions.

Balanced Scorecard Perspectives	Energy Project Evaluation Dimensions	Dimension Weights	Criteria	Local Weights	Global Weights
Finance	Project Performance (Dimension 1)	0.248	Investment Cost (Criterion 1)	0.503	0.125
			Return on Investment (Criterion 2)	0.497	0.123
Customer	Corporate Reputation (Dimension 2)	0.223	Financial Reputation (Criterion 3)	0.471	0.105
			Market Reputation (Criterion 4)	0.529	0.118
Internal Process	Operational Effectiveness (Dimension 3)	0.278	Technical and Organizational Effectiveness (Criterion 5)	0.511	0.142
			Financial Effectiveness (Criterion 6)	0.489	0.136
Learning and Growth	Competitive Structure (Dimension 4)	0.250	Growth Potential (Criterion 7)	0.461	0.115
			Market Risks (Criterion 8)	0.539	0.135

Table 6. states that operational effectiveness (Dimension 3) is the most important dimension for the financial institutions to make funding decision for large-scale energy projects. However, corporate reputation (Dimension 2) has the lowest significance. On the other hand, technical and organizational effectiveness (Criterion 5) and financial effectiveness (Criterion 6) are the most important criteria that financial institutions should pay attention in this process.

4.3. Ranking the Alternatives

In the final stage of the analysis, the performance of the bank types in energy financing process are compared by using IT2 fuzzy QUALIFLEX approach. For this purpose, state (Alternative 1), private (Alternative 2) and foreign (Alternative 3) banks are defined as alternatives. In the analysis, banks are divided into three different categories. The main reason is that it is aimed to understand which bank types have problems with respect to the financing energy investment projects. Because energy investment projects are vital for the sustainability of economic development in the country, energy financing decision should be made appropriately. In this framework, diving banks into three different categories will be helpful to understand which bank types have risks in this process. In other words, with the help of this classification, any problems regarding financing energy investment can be identified specifically. This situation has a contributing effect to solve the problems in this issue earlier. In the first aspect, decision matrix is generated which is shown in Table 7.

Table 7. Decision Matrix.

	State-Owned Banks (Alternative 1)	Private Banks (Alternative 2)	Foreign Banks (Alternative 3)
C1	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))	((0.78, 0.82, 0.89, 0.91;0.80), (0.72, 0.78, 0.92, 0.97; 1.00))	((0.78, 0.82, 0.89, 0.91;0.80), (0.72, 0.78, 0.92, 0.97; 1.00))
C2	((0.61, 0.65, 0.73, 0.76;0.80), (0.54, 0.61, 0.77, 0.83; 1.00))	((0.91, 0.93, 0.96, 0.97;0.80), (0.88, 0.92, 0.97, 0.99; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))
C3	((0.57, 0.60, 0.68, 0.72;0.80), (0.49, 0.56, 0.73, 0.79; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))	((0.89, 0.93, 0.96, 0.96;0.80), (0.86, 0.91, 0.97, 0.99; 1.00))
C4	((0.65, 0.67, 0.76, 0.79;0.80), (0.58, 0.63, 0.80, 0.86; 1.00))	((0.89, 0.93, 0.96, 0.96;0.80), (0.86, 0.91, 0.97, 0.99; 1.00))	((0.89, 0.93, 0.96, 0.96;0.80), (0.86, 0.91, 0.97, 0.99; 1.00))
C5	((0.61, 0.65, 0.73, 0.76;0.80), (0.54, 0.61, 0.77, 0.83; 1.00))	((0.97, 0.99,1.00,1.00;0.80), (0.95, 0.99,1.00,1.00; 1.00))	((0.86, 0.88, 0.92, 0.94;0.80), (0.81, 0.85, 0.95, 0.98; 1.00))
C6	((0.74, 0.77, 0.84, 0.87;0.80), (0.67, 0.73, 0.88, 0.93; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))	((0.84, 0.87, 0.92, 0.94;0.80), (0.79, 0.85, 0.95, 0.98; 1.00))
C7	((0.89, 0.93, 0.96, 0.96;0.80), (0.86, 0.91, 0.97, 0.99; 1.00))	((0.89, 0.93, 0.96, 0.96;0.80), (0.86, 0.91, 0.97, 0.99; 1.00))	((0.78, 0.82, 0.89, 0.91;0.80), (0.72, 0.78, 0.92, 0.97; 1.00))
C8	((0.53, 0.57, 0.65, 0.68;0.80), (0.45, 0.53, 0.69, 0.76; 1.00))	((0.79, 0.82, 0.88, 0.90;0.80), (0.74, 0.80, 0.91, 0.94; 1.00))	((0.74, 0.77, 0.84, 0.87;0.80), (0.67, 0.73, 0.88, 0.93; 1.00))

After that, concordance/discordance index is identified. The details are indicated on Table 8.

Table 8. Comprehensive concordance/discordance index.

P_1	$I_j^1(A_1, A_2)$	$I_j^1(A_1, A_3)$	$I_j^1(A_2, A_3)$	I^1	$d\left(I^1, \widetilde{0}_1\right)$
	((−7.54, −6.65, −4.91, −4.19; 0.80), (−5.14, −5.61, −8.25, −10.49; 1.00))	((−6.39, −5.55, −3.88, −3.18; 0.80), (−10.62, −7.75, −3.55, −2.14; 1.00))	((0.71, 0.87, 1.26, 1.45; 0.80), (0.45, 0.80, 1.77, 2.42; 1.00))	((−13.23, −11.33, −7.53, −5.91; 0.80), (−15.31, −12.56, −10.03; −10.20; 1.00))	−22.28
P_2	$I_j^2(A_1, A_3)$	$I_j^2(A_1, A_2)$	$I_j^2(A_3, A_2)$	I^2	$d\left(I^2, \widetilde{0}_1\right)$
	((−6.39, −5.55, −3.88, −3.18; 0.80), (−10.62, −7.75, −3.55, −2.14; 1.00))	((−7.54, −6.65, −4.91, −4.19; 0.80), (−12.26, −9.13, −4.73, −3.37; 1.00))	((−1.45, −1.26, −0.87, −0.71; 0.80), (−2.42, −1.77, −0.80, −0.45; 1.00))	((−15.39, −13.46, −9.66, −8.07; 0.80), (−25.30, −18.65, −9.07, −5.95; 1.00))	−27.32
P_3	$I_j^3(A_2, A_1)$	$I_j^3(A_2, A_3)$	$I_j^3(A_1, A_3)$	I^3	$d\left(I^3, \widetilde{0}_1\right)$
	((4.19, 4.91, 6.65, 7.54; 0.80), (3.37, 4.73, 9.13, 12.26; 1.00))	((0.71, 0.87, 1.26, 1.45; 0.80), (0.45, 0.80, 1.77, 2.42; 1.00))	((−6.39, −5.55, −3.88, −3.18; 0.80), (−10.62, −7.75, −3.55, −2.14; 1.00))	((−1.50, 0.23, 4.03, 5.82; 0.80), (−6.80, −2.22, 7.35, 12.55; 1.00))	5.04
P_4	$I_j^4(A_2, A_3)$	$I_j^4(A_2, A_1)$	$I_j^4(A_3, A_1)$	I^4	$d\left(I^4, \widetilde{0}_1\right)$
	((0.71, 0.87, 1.26, 1.45; 0.80), (0.45, 0.80, 1.77, 2.42; 1.00))	((4.19, 4.91, 6.65, 7.54; 0.80), (3.37, 4.73, 9.13, 12.26; 1.00))	((3.18, 3.88, 5.55, 6.39; 0.80), (2.14, 3.55, 7.75, 10.62; 1.00))	((8.07, 9.66, 13.46, 15.39; 0.80), (5.95, 9.07, 18.65, 25.30; 1.00))	27.32
P_5	$I_j^5(A_3, A_1)$	$I_j^5(A_3, A_2)$	$I_j^5(A_1, A_2)$	I^5	$d\left(I^5, \widetilde{0}_1\right)$
	((3.18, 3.88, 5.55, 6.39; 0.80), (2.14, 3.55, 7.75, 10.62; 1.00))	((−1.45, −1.26, −0.87, −0.71; 0.80), (−2.42, −1.77, −0.80, −0.45; 1.00))	((−7.54, −6.65, −4.91, −4.19; 0.80), (−12.26, −9.13, −4.73, −3.37; 1.00))	((−5.82, −4.03, −0.23, 1.50; 0.80), (−12.55, −7.35, 2.22, 6.80; 1.00))	−5.04
P_6	$I_j^6(A_3, A_2)$	$I_j^6(A_3, A_1)$	$I_j^6(A_2, A_1)$	I^6	$d\left(I^6, \widetilde{0}_1\right)$
	((−1.45, −1.26, −0.87, −0.71; 0.80), (−2.42, −1.77, −0.80, −0.45; 1.00))	((3.18, 3.88, 5.55, 6.39; 0.80), (2.14, 3.55, 7.55, 10.62; 1.00))	((4.19, 4.91, 6.65, 7.54; 0.80), (3.37, 4.73, 9.13, 12.26; 1.00))	((5.91, 7.53, 11.33, 13.23; 0.80), (3.08, 6.51, 16.08, 22.43; 1.00))	22.28

Table 8 indicates that $P_4 = (A_2, A_3, A_1)$ is the best alternative. It means that private banks are the most successful in the financing energy investment projects. On the other side, state banks are in the last place.

5. Discussion and Conclusions

The aim of this study is to determine what is effective in financial institutions' lending process of large-scale energy projects. In this context, a three-stage analysis is applied. Firstly, a wide literature review has been made and 4 dimensions and 8 criteria have been determined which can be effective in these decisions of financial institutions. The perspectives of the BSC method are taken into account in determining these criteria. In the second stage of the analysis, by using IT2 fuzzy DEMATEL method, the importance weights of these criteria are identified. In the last part of the study, state, private and foreign banks are ranked according to the financial performance of energy projects with IT2 fuzzy QUALIFLEX approach.

According to the results of the analysis, the financial and technological adequacy of the company requesting credit for energy projects should have the greatest effect on the decision of the financial institutions to give credit to this company. When this result is taken into consideration, it is understood that financial institutions should first analyze the financial data of the company requesting credit effectively. In this context, especially for companies with high indebtedness and liquidity risk, credit demand for energy projects should not be accepted. In addition, financial institutions should check whether the technological infrastructure of the firms requesting loans for large-scale energy projects is sufficient. Since it is not possible to control this issue on the financial statements, it will be beneficial for the personnel working in financial institutions to visit the company requesting credit physically.

In addition to these issues, private banks have been identified as the most successful type of banks in financing large-scale energy projects. However, it is understood that state banks have the lowest performance in this regard. Therefore, it would be appropriate for state banks to be more careful when financing these projects. Energy projects are long-term and high-cost investments. Therefore, banks should be more selective when lending such projects. Otherwise, if the energy investing company fails, it is inevitable that financial institutions will suffer serious damage from this process. In this context, state banks should conduct an effective analysis especially on the technological and financial adequacy of the companies mentioned in the article.

In this study, which issues should be considered in financing large-scale energy projects are examined. In this context, BSC based dimensions and criteria were analyzed by IT2 fuzzy DEMATEL approach and 3 different bank types were ranked by IT2 fuzzy QUALIFLEX method. The use of different approaches such as fuzzy ANP and fuzzy MOORA in the analysis process of a new study will also contribute to the literature. It will be possible to compare the new results with the results of this study. On the other hand, the main limitation of this study is that the dimensions and criteria are identified specifically to the large-scale energy investment projects. This limitation and research factors could be revised if the innovative and middle scale projects are also available for the other investments. In other words, these items may not be appropriate to other type of projects. Thus, in another study, criteria list can be generated for different project type. Another limitation is that the results are given by using the multi-criteria decision-making approach based on fuzzy sets. Monte Carlo simulation could be also applied for the extensive results. Accordingly, the analysis outcomes could be discussed by comparing the stochastic values of simulation analysis to provide more comprehensive weighting and ranking results for the future studies.

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