

Research Article

Gaussian-Based Soft Computing Approach to Alternative Banking System for Sustainable Financial Sector

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This study aims to identify the necessary strategies for the development of a sustainable financial system. For this purpose, a novel approach could be provided for soft computing with Gaussian-based fuzzy DEMATEL approach to understand the significant levels and impact-relation degrees of these criteria. For robustness check, this evaluation has also been performed for triangular and trapezoidal fuzzy sets. There are many novelties of this study. Firstly, computer science has a significant role in the decision-making process. Another specificity is that the use of Gaussian numbers with fuzzy numbers is a new area. In addition, interval type-2 fuzzy (IT2F) sets also provide a significant advantage in decision-making under uncertainty. The results demonstrate that the size of the alternative financing, investment in efficient projects, and effective advertisement/promotions are the most important items to affect the performance of alternative banking system of emerging economies. Hence, it is recommended that the new banking applications should be applied by the state or the state can provide some incentives for foreign banks to invest in emerging economies, such as tax reduction. Another important point is that the financial intermediations should generate a component financial analysis team to examine the financial reports of the companies in detail so that the financial credibility of these companies can be evaluated more effectively.

1. Introduction

The banking system plays a key role in the effectiveness of financial markets. Banks bring together the parties that have accumulation in the country and those who need money. This has significant benefits for both parties. Those with surplus funds can earn income with the help of banks [1]. On the contrary, companies can easily access the fund they need with the support of banks [2]. Briefly, banks support the efficient flow of funds in the country. This situation contributes significantly to the economic development of the country.

As a matter of fact, one of the main reasons for the formation of economic and financial crises is the unethical economic actions of the owners of financial institutions, especially banks, and also the managers and employees of these institutions. The commercial relationship established by banks and akin institutions with companies and

consumers based on trust ethically is critical for a sustainable solid financial system. For this reason, in financial institutions, it is necessary not only to regulate legal regulations but to go beyond this, to transform the corporate business mentality, and to develop individual moral sensitivity [3]. Otherwise, people and corporate structures that will try to overcome legal obligations in order to maximize profits will occur again. In this context, it is necessary to establish alternative banks that take ethical concerns as a matter and to operate with sensitiveness to the people, society, and environment [4]. Nevertheless, it is crucial to differentiate ethical banks from poverty-alleviation banks. While the former aims to provide banking services in the most general way with social and environmental responsibility awareness, the latter is specifically focused on economic development by providing special financial support through microcredits [5].

These considerations made it necessary to develop the alternative ways of financial service and products in the

banking sector. The participation system in the banking sector is one of alternative financing activities and could be developed to meet these needs. Alternative ethical banks are different from their conventional banking competitors in which they are embedded in social values, observe social balance, and aim to finance environmentally friendly projects [5]. The most important difference of this system from the traditional banking system is to convey the cash flows to the production directly. By this way, depositors could present their assets by being an asset holder, and they can get a profit from the production if it could be successful. In some cases, guarantees can be obtained in case of abuses of funding. In fact, in case of unsuccessful business results, generally the deposits may face losses. This consequence is a clear evidence that the risky investments could bring more profit than the conventional financial operations [6].

Theoretical studies about particularly alternative banking were started after 1955's. Until this time, there were some banking operations similar to operations worldwide. Western and Gulf countries deal with the alternative financing projects for the sustainable economics. The potential of alternative banking increases day by day and goes up to 2 trillion USD [7]. Development and investment banking activities are conducted by several emerging economies prominently for the sustainable economic growth [8]. However, International Monetary Fund (IMF) and World Bank implement the related reforms for the alternative banking activities.

It is possible to talk about the many benefits of the alternative financial system to the sustainable economies. First, the companies and individuals who are sensitive to interest are also added to the financial system, thanks to these banks [9]. This will contribute to the increase of the assets in the financial system and the development of the economy. In addition, the alternative financial system could not provide consumer loans to individuals without a clear analysis and justification. This situation can prevent unnecessary expenditures for sustainability. In addition, alternative financing channels contribute to the increase of sustainable investments in the emerging countries. This helps the economy to grow and reduce unemployment for sustainable economic growth [10].

The popularity of alternative financing increases in the last decades, the efficiency of the financial system is discussed by considering the participation-based financial investments in the emerging economies, and some debates also focus on this problem for the sustainable economic growth [11, 12]. The fund suppliers with the alternative banking system could force the financial system and reveal the competitive background on the alternative financing system. The organizational competency and customer need of financial institutions are also among the issues for developing new financing services [13, 14]. Accordingly, effective marketing strategies and technological development can also be effective in this process [15, 16].

What is important here is to determine which factors will be more important on a country-by-country basis. In this context, a very detailed analysis is required. Within this

scope, the methods to be used are significant. Otherwise, there is a risk that the quality of the analysis is not very good. Multicriteria decision-making methods are frequently preferred approaches in the literature for this purpose [17, 18]. The main purpose of these methods is to make the right decision among different alternatives in complex environments. These methods can also be considered in the framework of fuzzy logic [19, 20]. In this way, it is possible to reduce uncertainty to a minimum.

Additionally, the fuzzy methods could be modified to decrease the uncertainty and Gaussian approach could provide more precise results by using the different kinds of alpha-cut levels in the multicriteria decision-making techniques with fuzzy sets. For that, the Gaussian approach is combined with the fuzzy sets and the results are compared with the triangular and trapezoidal fuzzy sets, respectively. The aim of this study is to determine the issue of increasing the efficiency of alternative financing in emerging economies. In this context, firstly, a comprehensive literature review on the subject has been made. As a result of this study, 11 different factors were identified, which could increase the effectiveness of the participation system in finance. Furthermore, these factors are weighted using the fuzzy DEMATEL method for emerging economies. In this way, it will be possible to develop effective strategy proposals for this company.

Herewith, the research question of this study is which criteria should be given priority for the alternative banking system to be established to provide a more sustainable financial sector. Within the scope of this research, the hypothesis is as follows. The banking system is of vital importance, but it is not sufficient in its current form. An alternative banking system that is more sensitive to social and environmental issues should be established so that it can be a more sustainable financial system.

Besides, it is possible to mention the contribution of this study to the literature in many ways. First of all, in this study, a different set of criteria was generated for the development of the alternative finance. These criteria can be weighted for other country groups in a new study and effective strategies can be produced. Another important novelty of this proposed model is considering three different fuzzy sets in the evaluation process. With the help of this situation, it can be possible to assess the coherency and reliability of the analysis results. On the other side, because uncertainties can be handled more effectively, considering fuzzy sets provides many advantages. Another important contribution of this study is that the analysis is made on emerging economies. In this way, it could be possible to gain great attention for the alternative financing facilities in the sustainable economies. Moreover, it is the first study in which triangular, trapezoidal, and Gaussian fuzzy DEMATEL approaches are considered together regarding the measurement of the effectiveness of the alternative financing system. It is thought that this situation increases the originality of this analysis.

There are 5 different sections in this study. In Section 1, which is the introduction part of the study, general information about the subject is shared. Comprehensive literature regarding the study is given in Section 2. On the

contrary, detailed information relating to the methodology is given in Section 3 of the study. Section 4 of the study involves the application made for understanding the strategic priorities with the sustainable conditions of emerging economies. Section 5 of the study covers the results of the analysis and the further strategies developed.

2. Literature Review

There is a wide literature on alternative financing. In this section, the studies on making alternative banking more effective will be given. According to a significant part of the studies, the alternative system in the banking industry can be more effective by offering different products to their customers. For example, Possumah et al. [21] conducted an analysis of banking in Ghana and highlighted the need for different products. Ezeh and Nkamnebe [22] also stated the importance of the same issue for Malaysia and Nigeria. On the contrary, Albashir et al. [23] and Aysan et al. [24] argued that the financial system should offer different products that could be satisfied by customers.

The fact that all transactions of banks are in compliance with the ethical rules is another issue that stands out for the effectiveness of alternative financing. Legal rules play a very important role in the efficient execution of a system. However, compliance with legal rules may not show that ethical factors are also taken into consideration [4]. For instance, during the global mortgage crisis occurred in 2008, the banks did not act illegally, but they exhibited a lack of morality. This financial crisis has led to the deterioration of the effectiveness of the financial system, causing many people to lose their jobs and many companies to go bankrupt. As can be understood from here, making regulations alone is not enough to increase the sensitivity to ethical rules. In this framework, an effective education policy should contribute to the development of this system [25]. Asad et al. [26] conducted a research on the banking system in Pakistan. According to the results of the analysis, it is determined that the compliance of banks' transactions with the ethical priorities will increase their confidence in the market. Hassan et al. [27] and Anouze et al. [28] stated that this situation would be perceived as positive by people in case of strict regulations. On the contrary, Hashim et al. [29] and Belwal and Al Maqbali [30] also stated that the quality of regulations is also important for the customer preference. In the literature, there are also some theoretical studies which highlighted the significance of the ethical aspects for the sustainable financial development [31, 32]. In this sense, constituting the alternative banking system concerning ethical values within the manner of social embeddedness and environmental consciousness, it will play an important role in increasing the sustainable effectiveness of the alternative financing system.

In a significant part of the studies, it has been claimed that the quality of staff is very important in increasing the efficiency of alternative banking. Akhtar et al. [14] conducted a research on this system in Malaysia and Pakistan. As a result of the examinations conducted, it was found that the personnel capacity is the most important issue. Similar to the

study mentioned, Abbas et al. [33] conducted a study on employee quality and efficiency of banks and found a positive relationship between these two variables. In addition, the ability of the alternative banking system to innovate products and services is also significant to increase the efficiency. Thus, the banks should provide new products and services that consider social and environmental factors, such as more cost-effective loans to companies with low carbon emissions, support for environmentally friendly cars and industrial products, and production-oriented credit policy. Shah et al. [34] stated that the products of banks are different from traditional banks. Therefore, they argued that the staff of banks should dominate these differences. According to Visuvalingam et al. [35], financial institutions should provide very good training to their staff. Then, it will be possible for the staff to have a broad knowledge of different products in the banking system.

Macroeconomic factors may also influence the effectiveness of the financial system. For example, Hamza and Saadaoui [36], Imam and Kpodar [37], and Bashir [38] found a positive relationship between the economic development of the country and the effectiveness of alternative financing. On the contrary, Selim and Hassan [39] concluded that the increase in the unemployment rate in the country would adversely affect the success of the banking industry. In addition to the studies mentioned, Kusmayadi et al. [40] and Abidin and Haseeb [41] also investigated which factors affect the effectiveness of alternative financing. According to the results of the analysis, the uncertainty in the market will increase if inflation is high, and this situation will cause the rise of the problematic loans of banks. Similarly, Kosmidou [42], Abreu and Mendes [43], and Sufian and Kamarudin [44] underlined the importance of this situation. In addition, Komijani and Taghizadeh-Hesary [45] and Rafay and Farid [46] stated that the size of banking system in the country is important.

Some of the researchers emphasized that banks' own policies are also important in this framework. For example, Mehmood and Sabeeh [47] and Nemati et al. [48] stated that it is important for the financial institutions to carry out an effective marketing strategy. On the contrary, Nemati et al. [48] and Hamza and Saadaoui [36] emphasized that the prices of banking transactions should be competitive. Moreover, Zarrouk et al. [49] and Hassan and Bashir [50] defined that there is a strong relationship between the profitability and effectiveness of banks. In addition to the mentioned studies, Said [51], Devi and Rusydiana [52], and Makttoof and Khalid [53] identified that banks should invest in technological issues in order to increase their efficiency. According to some authors, effective customer relations play an important role in this context [54, 55]. In order to achieve this goal, it is very important that banks participate in corporate social responsibility activities [56–58]. There are many studies in the literature on the relationship between corporate social responsibility projects and financial performance. In the context of the trade-off hypothesis, there are studies showing that when conventional banks behave "socially responsible" [59, 60], their profitability rates decrease, or when they fund social responsibility projects

[61, 62], financial performance provides more social benefits in the long term within the stakeholder framework [63]. Beyond this, the main purpose of ethical banking is to increase social welfare and protect the environment. Furthermore, it contributes to the achievement of sustainable development by taking into account socio-cultural and environmental factors in cooperation with banking transactions based on the ethical way of doing business [4].

DEMATEL methodology was considered in the literature for many different purposes. For instance, Yalcin et al. [64] made an analysis about research and development project selection by using this approach. In addition, Karaşan and Kahraman [65] and Yang et al. [66] focused on environmental sustainability. On the other side, Dinçer et al. [67, 68], Dinçer and Yüksel [69], and Yüksel et al. [70] made an evaluation on energy industry with the help of the fuzzy DEMATEL method. Similar to the energy, the health industry was also examined with this approach by many researchers [71, 72]. Moreover, Dinçer et al. [73–76], Yüksel and Dinçer [77], and Zhang and Su [78] tried to make financial evaluation by considering DEMATEL. Furthermore, Dinçer et al. [79, 80] underlined the importance of the customer expectations with this methodology. In addition to them, Yadav and Singh [81], Wang et al. [82], and Moraga et al. [83] are also other studies which considered DEMATEL approach in their analyzes.

As a result of the literature review, it is seen that many researchers have focused on alternative financing in several ways. In these studies, different variables that can increase the effectiveness of banking are highlighted. On the contrary, in these studies, regression and questionnaire analyzes were generally used. Therefore, it is understood that there is a need for a new study to be done with a different method. Also, in this study, in order to resolve the deficiencies identified, factors that increase the efficiency of alternative financing for sustainable economics is analyzed with the comparative methods of fuzzy DEMATEL.

3. Methodology

In this section, firstly, theoretical information of fuzzy logic is defined. After that, DEMATEL methodology is explained. In the next part, Gaussian approach is identified. Finally, necessary information is given regarding the proposed model.

3.1. Background of Fuzzy Logic. Fuzzy set theory was first introduced by Zadeh [84]. According to fuzzy set theory, an object may not necessarily belong to a set which is unlikely for the classical set theory. In this theory, it is possible for an object to be a member to the set. Therefore, it is one of the most preferred theories which consider uncertainty in linguistic expressions. Additionally, it can also be seen that fuzzy logic was also used with multicriteria decision-making techniques especially in recent studies [85]. In this theory, expert expressions are symbolized by fuzzy numbers that take membership values in the range of 0 and 1 [86]. A fuzzy number is expressed as

$$\tilde{A} = \{(x), \mu_A(x), x \in S\}. \quad (1)$$

In this equation, $\mu_A(x)$ demonstrates the membership function of the x element. As a result, it is expressed in fuzzy numbers with a possibility value for linguistic expressions. Fuzzy numbers can be considered as geometric or statistics-based numbers, such as triangular, trapezoid, and Gaussian. Triangular fuzzy numbers are expressed as $\tilde{A} = (a, b, c)$. In this expression, a represents the lower value and its membership is zero. Similarly, c represents the upper value with zero membership. On the other side, b is the average value and membership value equals to 1 [87]. The mathematical expression of the membership functions of a triangular fuzzy number is demonstrated:

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b, \\ \frac{x-c}{b-c}, & b \leq x \leq c, \\ 0, & \text{otherwise.} \end{cases} \quad (2)$$

The details of fuzzy triangular number are illustrated in Figure 1.

Similar to triangular fuzzy numbers, trapezoidal fuzzy numbers are another type of fuzzy number that is widely used in the literature. A trapezoidal fuzzy number is shown as $\tilde{A} = (a, b, c, d)$. While the memberships of the expressions a and d are 0, the membership of b and c equals to 1 [88]. The mathematical expression of the membership function of a trapezoidal fuzzy number is explained as

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b, \\ 1, & b \leq x \leq c, \\ \frac{d-x}{d-c}, & c \leq x \leq d, \\ 0, & \text{otherwise.} \end{cases} \quad (3)$$

On the other side, the details of a fuzzy trapezoidal number are also given in Figure 2.

3.2. DEMATEL. DEMATEL method examines the inter-criteria interaction for decision-making in multicriteria situations. Thus, it is frequently used to identify the significance of different criteria in multicriteria decision-making problems [89, 90]. This method was developed by the Geneva Battelle Memorial Institute. The steps of the DEMATEL approach are given below:

Step 1: formation of direct relationship matrix.

In this step, firstly, expert evaluations are obtained. Within this framework, each criterion is compared with others to understand the relative superiority. Another important point is that average values of expert

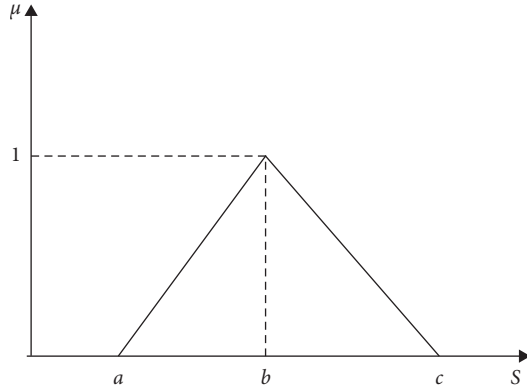


FIGURE 1: Triangular fuzzy number.

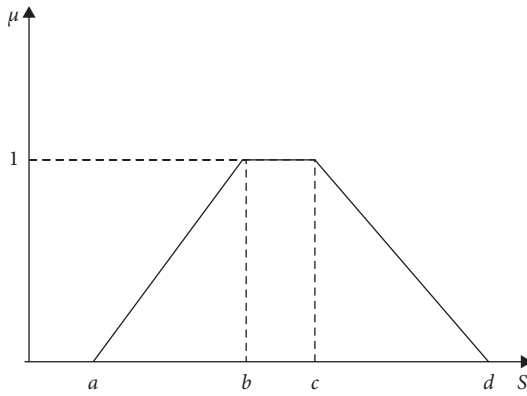


FIGURE 2: Trapezoidal fuzzy number.

evaluations are considered [91]. As a result, the direct relationship matrix can be generated. In this process, equations (4) and (5) are taken into consideration. In these equations, d_{ij}^k gives information about the scoring of the expert k between i and j criteria:

$$Z = \begin{bmatrix} 0 & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & 0 \end{bmatrix}, \quad (4)$$

$$z_{ij} = \frac{\sum d_{ij}^k}{n}. \quad (5)$$

Step 2: normalization of the direct relation matrix.

The sum of the row elements of the direct relationship matrix is calculated. Then, the maximum value of these totals is determined. After that, all elements in Z matrix are divided by this value [92]. Thus, Z matrix can be normalized. In this process, equations (6) and (7) are considered:

$$k = \max_{1 \leq i \leq n} \sum_j z_{ij}, \quad (6)$$

$$X = \frac{1}{k} \cdot Z. \quad (7)$$

Step 3: creating the total influence matrix (T).

In this step, equations (8) and (9) are used. In these equations, I represents the identity matrix [93]:

$$T = \lim_{k \rightarrow \infty} X + X^2 + \cdots + X^k, \quad (8)$$

$$T = X(I - X)^{-1} \quad (9)$$

Step 4: determination of the influencing and influenced criteria.

In this step, firstly, the sum of the row and column elements of the matrix T is calculated. For this purpose, equations (10)–(12) are considered. The column matrix of row totals is named as D , whereas R is the row matrix of the column totals [94, 95]:

$$T = [t_{ij}]_{n \times n}, \quad i, j = 1, 2, \dots, n, \quad (10)$$

$$D_i = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1}, \quad i = 1, 2, \dots, n, \quad (11)$$

$$R_j = \left[\sum_{i=1}^n t_{ij} \right]_{1 \times n}, \quad j = 1, 2, \dots, n. \quad (12)$$

Step 5: calculation of weights

The weights of the criteria are calculated based on $D_i + R_j$ values. Accordingly, the weights are calculated by dividing this value of each criterion to the total value as [96, 97]

$$w_i = \frac{D_i + R_i}{\sum_{i=1}^n (D_i + R_i)}. \quad (13)$$

3.3. *Gaussian Approach.* One of the fuzzy numbers is the Gaussian number. This number is similar to the normal distribution in statistics. A Gaussian fuzzy number is $\tilde{A} = (\mu, \beta)$. In this context, μ represents the mean and membership value equals to 1. Moreover, β is the standard deviation of the distribution [98]. The mathematical expression of the membership function is defined as

$$\mu_{\tilde{A}}(x) = e^{-((\mu-x)^2/\beta)}, \quad x \in S, \beta > 0. \quad (14)$$

The fuzzy Gaussian number is also depicted in Figure 3.

Another expression of fuzzy numbers is the representation of alpha levels as an interval. In this notation, the

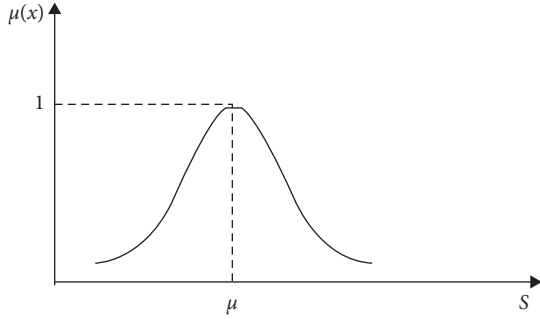


FIGURE 3: Gaussian fuzzy number.

alpha can take value between 0 and 1. A Gaussian number is expressed with the help of the alpha value. In this process, the lower and upper values of the fuzzy number can be taken into consideration as [99]

$$\tilde{A}_\alpha = [x^l, x^u] = [\mu - \beta\sqrt{-\ln(\alpha)}, \mu + \beta\sqrt{-\ln(\alpha)}], \quad \alpha \in [0, 1]. \quad (15)$$

Gaussian fuzzy numbers are returned to interval arithmetic. Thus, the interval is generated for DEMATEL. After that, the decision matrix (H) is created, and the details are given as [100]

$$H = \begin{bmatrix} [0, 0] & \cdots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{n1} & \cdots & [0, 0] \end{bmatrix}. \quad (16)$$

In this equation, $h_{ij} = [h_{ij}^-, h_{ij}^+]$ is closed interval of lower and upper values. Next, the largest of the row totals of the decision matrix is calculated. The elements of the matrix H are divided by this value, and the decision matrix can be normalized. This process is identified as

$$\sum_{j=1}^n h_{ij} = [g_i^-, g_i^+], \quad (17)$$

$$s = \max_{1 \leq i \leq n} \left(\frac{g_i^- + g_i^+}{2} \right),$$

$$X^\# = \frac{1}{s} H.$$

The normalized matrix $X^\#$ is defuzzified to generate the matrix X by

$$X = \frac{[(m+n) - (2v-1)(n-m)]}{2}, \quad (18)$$

and within this context, v can take a value of 1, 0.5, or 0 based on decision-makers' evaluation. On the other side, in the next process, total influence matrix is created, and the weights of the criteria are calculated with the help of D and R values. This process is similar to the steps 3–5 in DEMATEL approach with equations (8)–(13).

3.4. Proposed Model. In this study, it is aimed to identify significant priorities for an alternative banking system that

considers social and environmental issues so that sustainable financial sector can be generated. For this purpose, a novel model is proposed by considering fuzzy multicriteria decision-making (MCDM) methodology. In the first stage, appropriate criteria are determined which have an influence on the effectiveness of alternative financing. After that, these criteria are weighted by using DEMATEL approach based on Gaussian fuzzy sets. Finally, a comparative evaluation is also made with the help of triangular and trapezoidal fuzzy numbers. The main novelty of this proposed model is to define a criteria list that can affect the effectiveness of the alternative banking system. These factors pave the way for both top managers and academicians. Another important novelty of this proposed model is considering three different fuzzy sets in the evaluation process. In the literature, there are some studies which focused on the effectiveness of the alternative banking model [101, 102]. These studies mainly considered the regression analysis. On the other side, there are very limited studies which focused on the banking industry with Gaussian fuzzy numbers [103, 104]. Hence, it is thought that this study makes a contribution to the literature with a novel methodology as well. Moreover, considering DEMATEL methodology provides also some advantages because it creates impact-relation map. With the help of this situation, the causal relationship between the items can be identified. Furthermore, by making a comparative evaluation with three different fuzzy numbers, it is possible to assess the coherency and reliability of the analysis results. In addition to them, making analysis with fuzzy numbers can be very helpful to reach more effective results because they can handle the uncertainty in the decision-making process more appropriately. Nevertheless, the main drawback of this proposed model is reaching the result by only using DEMATEL methodology. Another comparative evaluation with a different MCDM model can also examine the appropriateness of the analysis results, as well.

4. An Application on the Emerging Economies

In this section, first of all, the criteria are explained. In addition to this situation, analysis results are also presented.

4.1. Identifying the Criteria. In the analysis process, firstly, appropriate criteria are selected which have an influence on the effectiveness of alternative financing in emerging economies. In this scope, the literature is reviewed in a detailed manner and 11 different criteria are identified. The details of these criteria are given on Table 1.

One of the prominent criteria for increasing the effectiveness of the alternative banking is the diversity of products and services. Alternative financing services, which can offer different products and services, can affect their customers more easily. Within this framework, new products and services which consider social and environmental issues can attract the attentions of the customers. For instance, loans with lower interest rates can be provided to the companies that have low carbon emission. In addition, the role of management is very important in this context. The

TABLE 1: The details of criteria.

Criteria	References
Variety of products/services (criterion 1)	Mohd Yusoff and Oseni [11]; Possumah et al. [21]; Ezeh and Nkamnebe [22]
Effectiveness of management (criterion 2)	Asad et al. [26]; Hassan et al. [27]; Anouze et al. [28]
Qualified employee (criterion 3)	Akhtar et al. [14]; Abbas et al. [33]; Shah et al. [34]
Macroeconomic conditions (criterion 4)	Dolgun et al. [6]; Hamza and Saadaoui [36]; Kusmayadi et al. [40]
Advertisement/promotions (criterion 5)	Mehmood and Sabeeh [47]; Nemati et al. [48]
Size of financial market (criterion 6)	Komijani and Taghizadeh-Hesary [45]; Rafay and Farid [46]
Competitive price (criterion 7)	Alam et al. [7]; Laela et al. [15]; Hamza and Saadaoui [36]
Technological development (criterion 8)	Said [51]; Makttoof and Khalid [53]
Effective customer relationship (criterion 9)	Hoque et al. [16]; Aldaihani and Ali [54]
Corporate social responsibility activities (criterion 10)	Azad et al. [105]; Nor and Hashim [58]
Investment in efficient projects (criterion 11)	Belwal and Al Maqbali [30]; Visuvalingam et al. [35]

TABLE 2: Linguistic variables for Gaussian fuzzy numbers.

Influence level	Gaussian fuzzy number	
No (N)	0.2	0.1
Low (L)	0.35	0.1
Medium (M)	0.5	0.1
High (H)	0.65	0.1
Very high (VH)	0.8	0.1

competence of the people who work here will give confidence to the customers. In this way, people who are sensitive to ethical rules will be able to choose these banks more safely. Moreover, it is of great importance that the employees at the bank are competent. The main reason is that the products and services of alternative banking are different than traditional bank types. Therefore, personnel should have a good understanding of the details of these products. Furthermore, staff must also have the ability to communicate effectively in order to successfully transfer these products to the customer.

On the contrary, macroeconomic conditions in the country may also have an impact on the banking system. For example, in an environment where the economy is shrinking, the alternative service and productions in banking sector, like all other sectors, is adversely affected. Additionally, if there is high inflation problem in the country, this situation negatively affects the effectiveness of the alternative banking system as well. The main reason is that, in an uncertain environment, the companies will be reluctant to make new investments which create a barrier for the development of the financial system. Another important factor is the effective marketing ability of the banking industry. These banks should emphasize on not only the compliance of these products with regulations and ethical rules but also the economic advantages it provides to people. In addition, the size of the banking system in the country is effective in this context. In addition, financial institutions need to offer their customers a competitive price advantage over other banks. Otherwise, these banks will only be able to work with customers who care about the strict rules. This situation could consider strictly for the development of the banking industry.

In addition, technological developments will have a positive impact on banking as in other sectors. Moreover, establishing positive relationships with customers will contribute to the

development of banking services. Banks that understand customers' expectations, develop products and services for this purpose, and listen to customers' complaints will provide a competitive advantage. On the contrary, participation in corporate social responsibility projects will improve the image of banks in the eyes of customers. Finally, banks are required to lend to successful projects. Otherwise, the profitability of these banks will be adversely affected, and this will prevent the continuity of the banking system. However, the alternative banking system should give importance to both profitability and social-environmental issues. Otherwise, they cannot be different from the traditional banks if they only focus on the profitability. In this context, the alternative banking system has a positive contribution to the sustainable financial development.

4.2. Calculating the Weights of the Criteria with Gaussian Fuzzy DEMATEL. In this part of the analysis, these criteria are weighted by using fuzzy DEMATEL approach with Gaussian fuzzy numbers. In the analysis process, Gaussian fuzzy numbers are considered and are demonstrated on Table 2.

After that, three decision makers made evaluations regarding the criteria. These experts have at least 10-year experience, and they are minimum middle-level managers. The details of their evaluations based on linguistic variables are given on Table 3.

By using the average values, initial direct relation matrix is created. The details of this matrix are illustrated on Tables 4–17. On the other side, this matrix is also normalized with the help of equations (6) and (7). In addition to them, the total-relation fuzzy matrix is generated by considering equations (10)–(12). In the next stage, the defuzzified total influence matrix is created. Hence, impact-relation map can be generated. The details are stated in Table 18.

TABLE 3: Linguistic evaluations of decision makers.

Title/ evaluations	C1			C2			C3			C4			C5			C6			C7			C8			C9			C10			C11			
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3				
C1	—	L	VH	—	L	N	L	N	L	N	N	L	N	N	H	N	N	H	N	N	L	N	N	H	N	N	L	N	N	H	N	N		
C2	H	H	VH	L	—	M	L	—	M	L	—	M	L	—	M	L	—	M	L	—	M	L	—	M	L	—	M	L	—	M	L	—		
C3	H	L	VH	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	L	L	N	
C4	M	L	H	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	
C5	N	H	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N
C6	H	VH	H	M	H	L	M	H	M	H	L	M	H	M	H	L	M	H	M	H	L	M	H	M	H	L	M	H	M	H	L	M	H	
C7	L	L	H	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	L	L	M	
C8	M	M	M	N	N	N	L	L	M	N	N	L	L	M	N	N	N	L	L	M	N	N	N	L	L	M	N	N	N	L	L	M	N	
C9	N	L	M	N	N	N	M	L	N	N	N	M	L	N	N	N	N	M	L	N	N	N	N	M	L	N	N	N	N	N	N	N	N	
C10	H	L	N	L	N	N	M	L	N	N	N	M	L	N	N	N	N	M	L	N	N	N	N	M	L	N	N	N	N	N	N	N	N	
C11	VH	L	M	H	N	M	H	M	H	N	M	H	N	M	H	N	M	H	N	M	H	N	M	H	N	M	H	N	M	H	N	M	H	

N: no; L: low; M: medium; H: high; VH: very high.

TABLE 4: Initial direct-relation triangular fuzzy matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11																									
C1	0	0	0.3	0.45	0.6	0.3	0.45	0.6	0.1333	0.3	0.4	0.4	0.5	0.7	0.3	0.5	0.6	0.3	0.5	0.6	0.5	0.6	0.8													
C2	0.45	0.6	0.7333	0	0	0.1667	0.3	0.45	0.1	0.2	0.4	0.3	0.4	0.6	0.4	0.5	0.7	0.3	0.4	0.6	0.2	0.4	0.5	0.4	0.5	0.7	0.5	0.6	0.7	0.5	0.6	0.8				
C3	0.55	0.7	0.8333	0.3	0.45	0.6	0	0	0.1833	0.3	0.5	0.5	0.6	0.7	0.5	0.7	0.8	0.4	0.6	0.7	0.5	0.7	0.8	0.6	0.8	0.9	0.3	0.5	0.6	0.5	0.7	0.8				
C4	0.35	0.5	0.65	0.1667	0.3	0.45	0.2667	0.4	0.55	0	0	0.3	0.5	0.6	0.4	0.5	0.7	0.8	0.3	0.5	0.6	0.3	0.5	0.6	0.4	0.5	0.6	0.4	0.5	0.7	0.5	0.6	0.7			
C5	0.2667	0.4	0.55	0.1667	0.3	0.45	0.25	0.4	0.55	0.1833	0.3	0.5	0	0	0.6	0.7	0.8	0.4	0.6	0.7	0.2	0.4	0.5	0.6	0.8	0.9	0.5	0.6	0.7	0.4	0.5	0.7	0.5	0.6	0.7	
C6	0.55	0.7	0.8333	0.45	0.6	0.75	0.45	0.6	0.75	0.3	0.5	0.6	0.4	0.5	0.7	0	0	0.6	0.7	0.8	0.4	0.6	0.7	0.5	0.6	0.8	0.5	0.6	0.8	0.5	0.6	0.8	0.5	0.6	0.7	
C7	0.3	0.45	0.6	0.1667	0.3	0.45	0.25	0.4	0.55	0.2667	0.4	0.6	0.6	0.8	0.9	0.5	0.6	0.7	0	0	0.3	0.5	0.6	0.5	0.7	0.8	0.2	0.3	0.5	0.4	0.5	0.6	0.7	0.5	0.6	
C8	0.35	0.5	0.65	0.1333	0.25	0.4	0.35	0.5	0.65	0.2333	0.4	0.5	0.6	0.7	0.8	0.5	0.6	0.8	0.5	0.7	0.8	0	0	0.6	0.8	0.9	0.3	0.4	0.5	0.4	0.5	0.6	0.7	0.5	0.6	
C9	0.2167	0.35	0.5	0.1833	0.3	0.45	0.25	0.4	0.55	0.1833	0.3	0.5	0.5	0.6	0.7	0.4	0.6	0.7	0.4	0.6	0.7	0.2	0.4	0.5	0	0	0.3	0.5	0.6	0.3	0.4	0.5	0.6	0.3	0.5	0.6
C10	0.2667	0.4	0.55	0.2333	0.35	0.5	0.2167	0.35	0.5	0.1833	0.3	0.5	0.4	0.6	0.7	0.3	0.5	0.6	0.3	0.4	0.6	0.1	0.3	0.4	0.5	0.6	0.8	0	0	0.2	0.4	0.5	0.6	0.3	0.4	
C11	0.4	0.55	0.6833	0.3167	0.45	0.6	0.45	0.6	0.75	0.35	0.5	0.7	0.5	0.6	0.8	0.5	0.6	0.7	0.5	0.6	0.8	0.3	0.4	0.6	0.3	0.4	0.6	0.3	0.4	0.6	0.3	0.5	0.6	0	0	0

TABLE 6: Initial direct-relation Gaussian fuzzy matrix.

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0	0.45	0.1	0.45	0.1	0.45	0.1	0.35	0.1	0.45	0.1
0.6	0	0.3	0.1	0.4	0.1	0.4	0.35	0.1	0.6	0.1
0.7	0.45	0.1	0	0.6	0.1	0.55	0.1	0.75	0.1	0.65
0.5	0.3	0.1	0.4	0.1	0.5	0.1	0.45	0.1	0.5	0.1
0.4	0.3	0.1	0.4	0	0.7	0.1	0.35	0.1	0.6	0.1
0.7	0.6	0.1	0.6	0.1	0	0.7	0.55	0.1	0.6	0.1
0.45	0.3	0.1	0.4	0.1	0.6	0.1	0.45	0.1	0.3	0.1
0.5	0.25	0.1	0.35	0.1	0.6	0.1	0	0.75	0.1	0.5
0.35	0.3	0.1	0.3	0.1	0.55	0.1	0.35	0	0.45	0.1
0.4	0.35	0.1	0.3	0.1	0.45	0.1	0.25	0.1	0	0.35
0.55	0.45	0.1	0.5	0.1	0.6	0.1	0.4	0.1	0.45	0

TABLE 7: Normalized direct-relation triangular fuzzy matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	
C1	0	0	0.04	0.06	0.08	0.04	0.06	0.08	0.1	0.04	0.06	0.08
C2	0.06	0.08	0.1	0	0	0.02	0.04	0.06	0.08	0.1	0.06	0.08
C3	0.08	0.1	0.11	0.04	0.06	0.08	0	0	0.03	0.04	0.06	0.08
C4	0.05	0.07	0.09	0.02	0.04	0.06	0.04	0.05	0.08	0	0	0.04
C5	0.04	0.05	0.08	0.02	0.04	0.06	0.03	0.05	0.08	0.03	0.04	0.06
C6	0.08	0.1	0.11	0.06	0.08	0.1	0.06	0.08	0.1	0.04	0.06	0.08
C7	0.04	0.06	0.08	0.02	0.04	0.06	0.03	0.05	0.08	0.04	0.05	0.08
C8	0.05	0.07	0.09	0.02	0.03	0.04	0.06	0.07	0.09	0.03	0.04	0.06
C9	0.03	0.05	0.07	0.03	0.04	0.06	0.03	0.04	0.06	0.03	0.04	0.06
C10	0.04	0.05	0.08	0.03	0.05	0.07	0.03	0.04	0.06	0.03	0.04	0.06
C11	0.05	0.08	0.09	0.04	0.06	0.08	0.1	0.05	0.07	0.09	0.06	0.08

TABLE 8: Total-relation triangular fuzzy matrix.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11																					
0.04	0.12	0.49	0.07	0.15	0.48	0.07	0.16	0.53	0.04	0.11	0.43	0.09	0.2	0.61	0.08	0.19	0.6	0.05	0.14	0.49	0.1	0.21	0.64	0.07	0.17	0.55	0.1	0.2	0.6			
0.1	0.19	0.58	0.03	0.09	0.4	0.05	0.14	0.5	0.04	0.11	0.42	0.08	0.18	0.59	0.09	0.19	0.6	0.08	0.18	0.58	0.06	0.14	0.49	0.09	0.2	0.63	0.09	0.19	0.56	0.1	0.2	0.59
0.12	0.24	0.68	0.07	0.17	0.55	0.04	0.13	0.53	0.06	0.14	0.5	0.12	0.24	0.72	0.12	0.25	0.72	0.11	0.23	0.7	0.1	0.21	0.6	0.14	0.27	0.76	0.09	0.2	0.63	0.12	0.24	0.69
0.09	0.19	0.6	0.05	0.14	0.48	0.07	0.16	0.54	0.03	0.09	0.39	0.09	0.2	0.63	0.09	0.2	0.63	0.11	0.22	0.64	0.07	0.16	0.52	0.09	0.21	0.65	0.08	0.18	0.57	0.1	0.21	0.62
0.08	0.18	0.58	0.05	0.14	0.48	0.07	0.17	0.54	0.05	0.13	0.45	0.05	0.14	0.55	0.12	0.23	0.65	0.1	0.21	0.63	0.06	0.15	0.51	0.13	0.24	0.68	0.1	0.2	0.58	0.09	0.2	0.61
0.12	0.24	0.7	0.09	0.19	0.58	0.1	0.21	0.64	0.07	0.16	0.53	0.11	0.24	0.72	0.06	0.17	0.63	0.13	0.25	0.73	0.09	0.2	0.6	0.12	0.26	0.76	0.11	0.22	0.66	0.11	0.24	0.7
0.08	0.19	0.59	0.05	0.14	0.48	0.07	0.16	0.54	0.06	0.14	0.46	0.12	0.24	0.66	0.11	0.22	0.64	0.05	0.14	0.54	0.07	0.16	0.52	0.12	0.23	0.68	0.06	0.16	0.55	0.09	0.2	0.61
0.09	0.2	0.62	0.05	0.14	0.5	0.08	0.19	0.58	0.06	0.14	0.48	0.12	0.24	0.69	0.11	0.23	0.67	0.12	0.23	0.67	0.03	0.11	0.47	0.13	0.26	0.72	0.08	0.18	0.59	0.09	0.21	0.64
0.06	0.16	0.54	0.05	0.13	0.45	0.06	0.15	0.51	0.05	0.12	0.42	0.1	0.2	0.61	0.09	0.2	0.6	0.09	0.19	0.59	0.05	0.14	0.48	0.04	0.14	0.54	0.07	0.17	0.53	0.08	0.18	0.57
0.07	0.16	0.52	0.05	0.13	0.44	0.06	0.14	0.48	0.04	0.11	0.4	0.09	0.19	0.58	0.08	0.18	0.56	0.07	0.17	0.55	0.04	0.12	0.45	0.1	0.2	0.6	0.03	0.1	0.44	0.07	0.16	0.53
0.1	0.21	0.63	0.07	0.16	0.52	0.1	0.2	0.59	0.07	0.16	0.5	0.11	0.23	0.68	0.11	0.23	0.67	0.11	0.22	0.67	0.07	0.17	0.54	0.09	0.21	0.68	0.08	0.19	0.6	0.05	0.14	0.56

TABLE 9: F_{ij} matrix (triangular).

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0.18	0.2	0.22	0.17	0.26	0.25	0.25	0.2	0.27	0.23	0.26
0.25	0.14	0.2	0.16	0.24	0.25	0.24	0.2	0.26	0.24	0.26
0.31	0.23	0.2	0.2	0.31	0.32	0.3	0.27	0.34	0.27	0.31
0.25	0.19	0.22	0.14	0.26	0.27	0.28	0.22	0.27	0.24	0.27
0.24	0.19	0.23	0.18	0.21	0.29	0.27	0.21	0.31	0.26	0.26
0.31	0.26	0.28	0.22	0.31	0.25	0.32	0.26	0.33	0.29	0.31
0.25	0.19	0.23	0.19	0.3	0.28	0.21	0.22	0.3	0.22	0.26
0.27	0.2	0.25	0.2	0.31	0.29	0.3	0.17	0.32	0.25	0.27
0.22	0.18	0.21	0.17	0.26	0.26	0.25	0.2	0.2	0.22	0.24
0.22	0.18	0.19	0.16	0.25	0.23	0.23	0.17	0.26	0.16	0.22
0.27	0.22	0.26	0.21	0.29	0.29	0.29	0.23	0.28	0.25	0.21

TABLE 12: Fij matrix (trapezoid).

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0.18	0.2	0.22	0.17	0.26	0.25	0.25	0.2	0.27	0.23	0.26
0.25	0.14	0.2	0.16	0.24	0.25	0.24	0.2	0.26	0.24	0.26
0.31	0.23	0.2	0.2	0.31	0.32	0.3	0.27	0.34	0.27	0.31
0.25	0.19	0.22	0.14	0.26	0.27	0.28	0.22	0.27	0.24	0.27
0.24	0.19	0.23	0.18	0.21	0.29	0.27	0.21	0.31	0.26	0.26
0.31	0.26	0.28	0.22	0.31	0.25	0.32	0.26	0.33	0.29	0.31
0.25	0.19	0.23	0.19	0.3	0.28	0.21	0.22	0.3	0.22	0.26
0.27	0.2	0.25	0.2	0.31	0.29	0.3	0.17	0.32	0.25	0.27
0.22	0.18	0.21	0.17	0.26	0.26	0.25	0.2	0.2	0.22	0.24
0.22	0.18	0.19	0.16	0.25	0.23	0.23	0.17	0.26	0.16	0.22
0.27	0.22	0.26	0.21	0.29	0.29	0.29	0.23	0.28	0.25	0.21

Table 18 indicates that the size of the financial market in the country (C6) is the most significant criterion to improve the effectiveness of alternative financing system because it has the highest weight. In addition, investment in efficient projects (C11) and effective advertisement/promotions (C5) are other significant factors in this framework.

4.3. A Comparative Evaluation with Triangular and Trapezoidal Fuzzy DEMATEL. In order to test the coherency and the reliability of the analysis results, a comparative evaluation has also been performed with the help of the triangular and trapezoidal fuzzy numbers. Table 19 gives information about the linguistic variables of these fuzzy sets.

By considering these values, the criteria weights are recalculated. The comparative analysis results are demonstrated on Table 20.

Table 20 shows that ranking of the criteria is quite similar in all calculations with triangular, trapezoidal, and Gaussian fuzzy numbers. This situation gives an idea about the coherency of the analysis results.

4.4. Discussion of the Analysis Results. The results indicate that the size of the financial market is the most important criterion to improve the effectiveness of alternative financing. This situation gives information that the country may not be appropriate for alternative financing when it does not have a powerful financial market. Therefore, companies should be encouraged to make investment in the financial market. For this purpose, new financial products should be created. This situation has a contributing effect on the liquidity amount in the market. Another important point for this situation is that uncertainties in the financial market should be minimized. In this context, legal infrastructure should be appropriate so that investors can feel secured to make investment in this market.

Many researchers in the literature underlined the importance of this situation. For instance, Komijani and Taghizadeh-Hesary [45] aimed to evaluate the details of Islamic banking system in Asia as an alternative approach. They have given information about the positive ways of this system. However, they also underlined that the most significant factor of the success of this alternative system is the size of the financial market. It is defined that it is very

difficult to develop this system effectively if the country does not have an improved financial market. Similar to this study, Rafay and Farid [46] also focused on the details of the Islamic banking system in Pakistan. They explained the details of this system and presented it as an alternative financing approach to emerging economies. In this study, it is concluded that having an improved financial market is an important indicator to create an alternative financing approach.

In addition to this issue, it is also determined that advertisement and promotions are very significant for the success of alternative financing. As can be seen from this result, effective promotion should be made in order to include the existing customer in the new financial system. Otherwise, no matter how good the newly developed alternative financial system is, customers will not be able to participate. Therefore, it should be ensured that investors have information about this new system through advertisements and announcements. It is important that ads are transparent and contain detailed information. In addition to the aforementioned issue, another issue that should be considered in the advertisements to be made is to specify the points where the alternative financing system developed is profitable from the existing system. This will facilitate investors' involvement in the new system.

The importance of advertisement and promotions was also considered in many different studies. For instance, Damon and Bayat [106] examined Islamic banking products in South Africa. They defined that Islamic banking in this country has low percentage in the system although there is high Muslim population. Hence, they discussed that these banks should improve their promotions about their products. Otherwise, it cannot be possible to increase the percentage of this alternative system. Parallel to this study, Mehmood and Sabeeh [47] evaluated the participation banking system in Pakistan. They tried to understand the ways to improve customer satisfaction. For this purpose, they identified that these banks should give priority to the effectiveness of the promotions.

Furthermore, investment in efficient projects is another important indicator to generate an alternative financing system. Thus, the institutions in this new financial system should make a detailed credibility analysis of the companies for the lending decisions. If these companies have financial

TABLE 13: Gaussian alpha cut = 0.5.

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11						
0	0.367	0.533	0.167	0.333	0.417	0.583	0.367	0.533	0.367	0.533	0.367	0.533	0.367	0.533	0.517	0.683
0.517	0.683	0	0.217	0.383	0.117	0.283	0.317	0.483	0.417	0.583	0.317	0.483	0.267	0.433	0.517	0.683
0.617	0.783	0.367	0.533	0	0.217	0.383	0.517	0.683	0.567	0.733	0.467	0.633	0.567	0.733	0.667	0.833
0.417	0.583	0.217	0.383	0.317	0.483	0	0.367	0.533	0.417	0.583	0.567	0.733	0.367	0.533	0.367	0.533
0.317	0.483	0.217	0.383	0.317	0.483	0.217	0.383	0	0.617	0.783	0.467	0.633	0.267	0.433	0.667	0.833
0.617	0.783	0.517	0.683	0.517	0.683	0.367	0.533	0.417	0.583	0	0.617	0.783	0.467	0.633	0.517	0.683
0.367	0.533	0.217	0.383	0.317	0.483	0.317	0.483	0.667	0.833	0.517	0.683	0	0.367	0.533	0.567	0.733
0.417	0.583	0.167	0.333	0.417	0.583	0.267	0.433	0.617	0.783	0.517	0.683	0.617	0.783	0.833	0.317	0.483
0.267	0.433	0.217	0.383	0.317	0.483	0.217	0.383	0.517	0.683	0.467	0.633	0.267	0.433	0	0.367	0.533
0.317	0.483	0.267	0.433	0.217	0.383	0.467	0.633	0.517	0.683	0.367	0.533	0.317	0.483	0.167	0.267	0.433
0.467	0.633	0.367	0.533	0.517	0.683	0.417	0.583	0.517	0.683	0.517	0.683	0.317	0.483	0.317	0.483	0

TABLE 14: Gaussian alpha cut = 0.1.

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0	0.298	0.602	0.298	0.602	0.298	0.602	0.298	0.602	0.298	0.602
0.448	0	0.148	0.452	0.048	0.352	0.248	0.552	0.348	0.502	0.448
0.548	0.298	0	0.148	0.452	0.448	0.752	0.498	0.802	0.498	0.802
0.348	0.652	0.148	0.452	0.298	0.348	0.652	0.498	0.802	0.348	0.652
0.248	0.552	0.148	0.452	0	0.548	0.852	0.398	0.702	0.448	0.652
0.548	0.852	0.448	0.752	0.448	0.652	0	0.398	0.702	0.448	0.752
0.298	0.602	0.148	0.452	0.248	0.552	0.248	0.298	0.602	0.148	0.452
0.348	0.652	0.098	0.402	0.348	0.448	0.752	0	0.598	0.802	0.348
0.198	0.502	0.148	0.452	0.448	0.398	0.702	0.198	0	0.248	0.602
0.248	0.552	0.198	0.402	0.398	0.702	0.248	0.098	0.448	0	0.502
0.398	0.702	0.298	0.602	0.448	0.448	0.752	0.248	0.552	0.298	0

TABLE 16: Normalized direct-relation Gaussian fuzzy matrix (alpha cut = 0.5).

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11		
0	0	0.062	0.09	0.028	0.056	0.071	0.099	0.062	0.09	0.062	0.09	0.088	0.116
0.088	0.116	0	0.037	0.065	0.048	0.054	0.082	0.071	0.099	0.054	0.082	0.082	0.116
0.105	0.133	0.062	0	0.037	0.065	0.088	0.116	0.096	0.124	0.079	0.107	0.113	0.141
0.071	0.099	0.037	0.065	0.054	0	0.062	0.09	0.071	0.099	0.096	0.124	0.062	0.09
0.054	0.082	0.037	0.065	0.054	0.082	0.037	0.065	0	0	0.079	0.107	0.045	0.073
0.105	0.133	0.088	0.116	0.088	0.116	0.062	0.09	0.062	0.09	0.105	0.133	0.079	0.107
0.062	0.09	0.037	0.065	0.054	0.082	0.054	0.082	0.088	0.116	0	0	0.062	0.09
0.071	0.099	0.028	0.056	0.071	0.099	0.113	0.141	0.088	0.116	0.096	0.124	0.037	0.065
0.045	0.073	0.037	0.065	0.054	0.082	0.037	0.065	0.065	0.088	0.116	0.141	0.054	0.082
0.054	0.082	0.045	0.073	0.045	0.073	0.037	0.065	0.028	0.056	0.054	0	0	0.062
0.079	0.107	0.062	0.09	0.071	0.099	0.088	0.116	0.054	0.082	0.088	0.116	0.062	0.09

TABLE 17: F_{ij} (Gaussian).

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0.354	0.339	0.383	0.283	0.471	0.459	0.45	0.347	0.498	0.405	0.459
0.44	0.264	0.355	0.271	0.449	0.458	0.435	0.341	0.482	0.421	0.452
0.553	0.409	0.394	0.354	0.588	0.589	0.564	0.467	0.635	0.491	0.562
0.454	0.334	0.396	0.259	0.49	0.491	0.505	0.381	0.51	0.432	0.483
0.442	0.337	0.398	0.309	0.422	0.523	0.493	0.368	0.557	0.451	0.47
0.561	0.436	0.492	0.381	0.582	0.497	0.593	0.459	0.622	0.52	0.563
0.449	0.335	0.398	0.323	0.534	0.509	0.408	0.383	0.542	0.407	0.471
0.484	0.349	0.437	0.335	0.56	0.54	0.538	0.335	0.59	0.447	0.5
0.397	0.307	0.364	0.283	0.472	0.46	0.452	0.337	0.399	0.393	0.424
0.378	0.295	0.334	0.264	0.435	0.417	0.402	0.301	0.461	0.299	0.383
0.491	0.378	0.449	0.355	0.541	0.536	0.527	0.397	0.536	0.453	0.42

TABLE 18: The total influence results and weights of the criteria.

Criteria	$D_i + R_i$	$D_i - R_i$	Weights
C1	9.452	-0.554	0.089
C2	8.154	0.584	0.077
C3	10.005	1.205	0.095
C4	8.150	1.319	0.077
C5	10.312	-0.772	0.098
C6	11.184	0.227	0.106
C7	10.126	-0.610	0.096
C8	9.231	0.998	0.087
C9	10.121	-1.542	0.096
C10	8.687	-0.749	0.082
C11	10.269	-0.106	0.097

TABLE 19: Linguistic variables for triangular and trapezoidal fuzzy numbers.

Influence level	Triangular fuzzy numbers			Trapezoidal fuzzy number			
No (N)	0.1	0.2	0.35	0.1	0.2	0.2	0.35
Low (L)	0.2	0.35	0.5	0.2	0.35	0.35	0.5
Medium (M)	0.35	0.5	0.65	0.35	0.5	0.5	0.65
High (H)	0.5	0.65	0.8	0.5	0.65	0.65	0.8
Very high (VH)	0.65	0.8	0.9	0.65	0.8	0.8	0.9

TABLE 20: Comparative analysis results.

Criteria	Weights with triangular fuzzy sets	Weights with trapezoidal fuzzy sets	Weights with Gaussian fuzzy sets
C1	0.090	0.090	0.089
C2	0.079	0.079	0.077
C3	0.095	0.095	0.095
C4	0.079	0.079	0.077
C5	0.096	0.096	0.098
C6	0.104	0.104	0.106
C7	0.095	0.095	0.096
C8	0.088	0.088	0.087
C9	0.095	0.095	0.096
C10	0.083	0.083	0.082
C11	0.096	0.096	0.097

problems, this situation should be defined in this detailed analysis. Otherwise, these banks may have high amount of nonperforming loans which leads to significant problems for these banks. Another important issue is that efficiency analysis of the projects should be performed in a detailed manner. Within this framework, the factors, such as cost, benefit, maturity, and cash flows, should be taken into consideration while lending money to the companies.

A lot of researchers identified the significance of this issue in their studies. In this context, Belwal and Al Maqbali [30] focused on the concept of participation banking system as an alternative financing system. For this purpose, a survey analysis was conducted with 60 different people. They reached the conclusion that the institution should make a detailed credibility analysis of the customers to improve this system. Moreover, Visuvalingam et al. [35] evaluated the foreign banking system

in Malaysia. They identified that projects should be analyzed effectively.

5. Conclusion

In this study, the aim is to focus on the ways of increasing the efficiency of alternative financing in emerging economies. In order to achieve this objective, firstly, similar studies in the literature are evaluated. Consequently, 11 different criteria are determined that may influence the effectiveness of alternative financing for the sustainable economics of emerging countries. In addition to this condition, comparative analysis of the fuzzy DEMATEL based on Gaussian method is considered to find the significance levels of these criteria and understand the coherency for the proposed method. As a result, it is found that the size of the alternative banking, investment in efficient projects, and effective advertisement/promotions are the most important items to affect the power of alternative financing in emerging economies. It is understood that the powerful financial system is a necessity to generate an alternative banking system. Therefore, it is recommended that new financial products should be created by the emerging countries so that financial system can be improved.

The main limitation of this study is only identifying the appropriate criteria to generate alternative banking system that considers social and environmental issues. Because of this situation, this study pioneers the establishment of an alternative banking system. However, in this study, there is no study on sectoral applications. It is necessary to analyze how the analysis results obtained in this study work in real life. As a result of the analysis made with different methods, it was seen that the results of the study were consistent. However, an applied analysis within the industry is also important in testing the accuracy of the criteria. Hence, in the future studies, new analyses can be made for industrial

applications. Additionally, another important point is that different methods can be considered in the new analysis. For example, VIKOR and TOPSIS approaches can be taken into consideration to rank the countries.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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