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Determination of Priority Factors for the Development of Green Banking Practices in Turkey with the Fuzzy DEMATEL Method

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ABSTRACT

The aim of this study is to determine the priority factors for the development of green banking practices in Turkey. In this context, with the literature review, five different factors that could be effective on the development of green banking activities were determined. After that, an analysis was carried out with the fuzzy DEMATEL method to determine the importance weights of these criteria. The biggest contribution of this study to the literature is the determination of more effective strategies for the development of green banking activities. According to the results of the analysis, the diversification of green financial products is the most important variable for the development of green banking applications in Turkey. Considering the analysis results of the study, banks should first diversify green financial products to develop green banking practices in Turkey. This situation contributes to the fact that banks can reach wider audiences. Thus, it will be possible to meet customer expectations for different segments more easily. In this framework, banks should primarily offer "green loans" to finance projects related to environmental sustainability.

Keywords: Green Banking, Green Credit, Green Credit Cards, New Product Development, Fuzzy DEMATEL

JEL Classification: C80, G21, O22

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1. INTRODUCTION

Green banking refers to the practices in which banks show sensitivity to environmental factors in their processes. Issues such as financing green investments, minimizing carbon emissions and energy efficiency are among the activities that can be shown as examples of green banking (Mukhtarov et al., 2022: 169). As can be understood from these definitions, it is very important for green banking activities that banks consider environmental benefits in their activities in addition to profit-oriented activities. As can be seen, green banking activities are directly related to the sustainable development of countries. It is possible to talk about the very serious benefits of these applications to banks (Khairunnessa et al., 2021:13). These practices can help banks manage environmental risks. In addition, thanks to these applications, banks can improve their image with customers. Banks that are sensitive to environmental issues will attract more attention from customers and this will provide banks with a significant competitive advantage.

As can be understood from the issues mentioned above, increasing green banking activities is of vital importance for the economic performance of both banks and countries. To develop green banking activities, it is necessary to pay attention to many different issues (Xu et al., 2023:168). First, it is necessary to diversify green financial products to develop green banking activities. Thanks to the diversification of these products, it is possible to better meet the expectations of different customers (Miah et al., 2021:2681). Since this will contribute to customer satisfaction, the competitiveness of banks will also be increased. Effective legal regulations are also important for the development of green banking activities. Thanks to these regulations, it will be possible to determine the standards in green banking activities. This will contribute significantly to increasing the reliability of green banking activities.

Government incentives also play an important role in the development of green banking activities. In this framework, it is possible to develop green banking activities thanks to government incentives such as tax reductions and low-interest loans (Sun et al., 2022:3). In addition to these, improving customer awareness is necessary to increase green banking activities. The fact that customers have more information about green banking services allows to increase the demand for these services. This situation encourages banks to focus on green projects. In other words, as customers' demands for environmentally friendly products and services increase, green banking activities will also improve significantly. In addition, technological development is another necessary factor to increase green banking activities (Sharma and Choubey, 2022:293). Thanks to technological development, it will be possible to develop innovative new products related to green banking activities. This will help promote green banking services to wider audiences.

The development of green banking activities is important for both the social and economic development of countries. Therefore, countries need to take the necessary actions to develop their green banking activities. However, each of the actions to be taken for the development of these activities also causes an increase in costs (Martínez et al., 2023: 4). For example, banks need to invest a significant amount to make technological improvements for the development of green banking activities. Similarly, new products to be created for the development of these activities will increase the costs of banks (Dong et al., 2022:321). Therefore, it is not financially possible for banks to make improvements for many factors in

order to develop green banking activities. Therefore, to develop these activities, it is necessary to focus on issues of greater importance. Thus, banks will be able to implement the necessary actions efficiently without being in financial difficulty.

In this study, it is aimed to determine the priority factors for the development of green banking practices in Turkey. In this context, firstly, a comprehensive literature analysis was carried out. As a result of this analysis, five different criteria that can be effective on the development of green banking activities have been determined. Subsequently, a priority analysis was conducted to determine the importance weights of these factors. In the related process, fuzzy DEMATEL method was used. Thanks to the analysis results to be obtained, it is aimed to present priority strategies to both policy makers and bank managers to develop green banking practices.

The important contributions of this study to the literature are listed below.

(i) Thanks to the priority analysis, it is possible to present more effective strategies for the development of green banking activities. It is possible to talk about many different factors that affect the development of these activities. On the other hand, all the actions to be taken to improve these factors also lead to an increase in costs. Therefore, it is necessary to determine more important factors to develop these applications without incurring high costs for banks. In this way, it is possible to develop green banking activities more effectively.

(ii) There are some advantages of using the DEMATEL method in calculating the weights of the criteria. To calculate the importance weights of the criteria, there are many different decision-making techniques in the literature. On the other hand, the biggest advantage of the DEMATEL method compared to the others is that it considers the causal relationship between the variables. There may be a cause-effect relationship between the factors affecting the development of green banking activities. For example, technological development can also affect the development of new products for green banking. Therefore, this issue should be considered in determining the most important criteria for the development of these activities. In this context, DEMATEL technique is thought to be the most optimal method for studies to be carried out for this purpose.

(iii) Considering the DEMATEL method together with fuzzy logic has some advantages. One of the most important problems in decision-making models is the inability to effectively manage the uncertainty in the process (Dinçer et al., 2023). Decision making problems are getting more and more complex. In order to manage this complexity correctly, the scope of the decision-making model to be created should also be developed. In this framework, it is aimed to minimize the uncertainty in the process by using the DEMATEL technique together with fuzzy numbers. This contributes to achieving more consistent and accurate results.

(iv) Considering the Turkish banking sector in the analysis process of the study also provides some benefits. Turkey is one of the developing countries with the largest economy. Therefore, the strategies to be developed to increase the green banking activities in this country will also be a guide for other developing countries.

The study consists of five different parts. After the introduction, a literature review is given. In the third chapter, the stages of fuzzy DEMATEL technique are explained. In the fourth chapter, the results of the analysis on the Turkish banking sector are shared. In the last section, conclusions and discussions are given.

2. LITERATURE REVIEW

According to many studies in the literature, government incentives should be given priority to develop green banking applications. Governments can help promote green banking activities in many ways. These ways include tax incentives, regulations, financial supports and public-private partnerships (Khairunnessa et al., 2021:10). At this point, governments bring regulations for green banking activities, enabling banks to focus more on loans that support environmental sustainability (Mir and Bhat, 2022: 9). Governments can provide financial support to banks that want to invest in green banking activities (Bouteraa et al., 2022:13). Miah et al. (2021) analyzed the current state of environmental performance of commercial banks operating in Oman. According to the results obtained, the government's preparation of green banking guidelines will have an important place in the development of green banking practices. Sharma and Choubey (2022) examined the impact of green banking initiatives by considering 36 middle and senior managers of 12 public and private Indian banks. As a result of the study, they argued that providing government support in green banking initiatives has a positive role in restoring customer trust. Alshebami (2021) and Park and Kim (2020) emphasized the importance of government incentives to encourage financial institutions, especially to invest in renewable energy sources.

The effectiveness of green banking practices is directly proportional to the diversification of green finance products. These products support sustainable, environmentally friendly and low carbon emission projects and provide high returns to investors (J. Chen et al., 2022:12). Therefore, it is important to develop new products that support environmental sustainability in the financial sector (Z. Chen et al., 2022: 9). Products such as green bonds, green loans, sustainable bonds, energy savings finance and environmental risk insurance provide a link between financing institutions and investors that support environmental sustainability (Julia and Kassim, 2020:729). Bukhari et al. (2020) discussed green banking practices in order to adopt a business structure based on environmental, social and governance (ESG) dimensions. As a result of this study, they stated that green banking practices will guide the adoption of green banking when supported by the diversity of financing products, a positive regulatory environment, relevant stakeholders, and knowledgeable workforce. Aslam and Jawaid (2022) examined the effect of diversification of financing products on the banking performance of GBAP (Green banking adoption practices). As a result of the study, they explained that product diversity is one of the key factors for being successful in green banking. Ellahi et al. (2021) and Chaudhry and Hussain (2023) revealed in their studies that it can contribute to the formation of a sustainable economy by offering suitable products to meet the needs of customers through the diversification of financing products.

Legal regulations are of great importance in the development of green banking practices. Legal regulations play an important role in issues such as ensuring sustainability in the financial sector, managing environmental and social risks, increasing transparency and accountability (Ratnasari et al., 2021:2). Legal regulations regarding green banking practices constitute the necessary framework for financial institutions to determine their policies on sustainability issues, monitor and report their practices (Hasan et al., 2022:3751). Another importance of legal regulations in the development of green banking practices is that it determines the obligations regarding the management of environmental and social risks (Kurowski et al., 2022:10). Debrah et al. (2022) conducted both bibliometric and qualitative

analysis of cutting-edge technologies and trends in green finance. As a result of this study, they showed that green banking is still an immature but interdisciplinary field of research. They discuss the role of regulation in the development of green banking practices. Chi et al. (2022) discussed the characteristics of green banking, how the legal framework can be shaped, and the importance of these regulations in green banking practices. Dedu et al. (2021) and Filipiak (2021) argued that the establishment of a regulatory framework for the development of green finance facilitates financial institutions to provide financing for green projects.

Customers play an important role in the success of green banking applications and therefore customer awareness is a critical factor in the development of green banking applications. The development and dissemination of green banking practices depends on raising customer awareness (Rehman et al., 2021:2) Customers' awareness of the environment and making conscious choices in this regard accelerates the adoption of green banking practices. Therefore, financial institutions should work to increase customer awareness (Zhang et al., 2022:8). Customer awareness is provided by financial institutions informing their customers about green banking practices. This information helps customers choose financial products and services that have a low environmental impact. For example, customers who want to invest in energy efficiency or renewable energy projects can benefit from financial products such as green mutual funds (Boitan, 2020:41). Donath et al. (2023) examined whether banks' decision-making attitudes to be environmentalists change through mutual interaction under the influence of other banks. As a result of the study, they argued that banks should increase customer awareness to help them choose financial products and services with low environmental impact. Stauropoulou et al. (2023) found that customer awareness has a positive effect on the adoption of green banking practices. Panda et al. (2020) and Taneja and Ali (2021) stated in their studies that customer awareness increases the effectiveness of information and training provided by banks to enable customers to adopt green banking practices.

In recent years, the use of sustainable financial products has been increasing rapidly. The role of technological developments and innovation is very important in accelerating this process. Thanks to technological developments, financial institutions can perform better data analysis, measure the environmental impact of their customers, and make their financial products more sustainable (Malik and Singh, 2022:5). It is of great importance in innovation in green banking. By offering innovative financial products, financial institutions can find more effective ways to minimize environmental impact. For example, it aims to finance environmentally friendly projects by investing in sustainable projects such as green bonds and energy efficiency projects (Sehen et al., 2022: 7). It is aimed that banks support environmentally friendly and socially beneficial practices, rather than just making a profit. To this end, the use of innovation and technological developments plays an important role in the development of green banking. Procopio et al. (2020) explored several ways in which Italian banking has become greener. As a result of this study, it was concluded that investors can be made to invest in renewable energy projects through online platforms. Ahmed et al. (2023) presented policy implications for promoting environmentally based technological innovation and financial sector development to increase green growth in the most polluted economies. Gunawan et al. (2022) and Afridi et al. (2023) emphasized the importance of technological innovations in the development of green banking applications. In addition,

they argue that the use of financial technologies (fintech) and blockchain technology in green banking can increase efficiency and enable the development of environmentally friendly financial products.

As a result of the literature review, it is possible to reach the following conclusions.

(i) Green banking applications have become very popular in the literature, especially in recent years.

(ii) Factors that can increase these practices such as government incentives and technological development have been emphasized in a significant part of the studies.

(iii) However, it is financially unlikely for investors to improve each of these factors simultaneously.

(iv) In this context, a new study is needed to determine the variables that are more important for the development of green banking applications.

Considering these important issues mentioned in the literature, a priority analysis is carried out for the factors affecting the development of green banking activities in Turkey in this study in order to eliminate this deficiency mentioned in the literature. In this framework, a new analysis is made using the fuzzy DEMATEL approach.

3. METHODOLOGY

DEMATEL method is a multi-criteria decision-making method used to determine the importance weights of different criteria. Thanks to this technique, it can be determined which of the variables affecting a goal is more important (Bhuiyan et al., 2022:565). In addition to the mentioned points, the DEMATEL method also allows the causality relationship between the criteria to be determined (Yüksel and Dinçer, 2022: 11). This situation is considered as one of the most important advantages of the DEMATEL method (Eti et al., 2023:3). In this study, the DEMATEL technique is considered together with the fuzzy logic approach (Wu et al., 2022:12). In this process, firstly, opinions are obtained from the expert team. In this framework, experts use a five-point scale when making evaluations. Then, with the help of Equations (1) and (2), the direct relation matrix is obtained.

$$\tilde{Z}=\begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \cdots & \tilde{z}_{1n} \\ \tilde{z}_{21} & 0 & \cdots & \cdots & \tilde{z}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & \cdots & 0 \end{bmatrix} \quad (1)$$

$$\tilde{Z} = \frac{\tilde{Z}^1+\tilde{Z}^2+\tilde{Z}^3+\cdots\tilde{Z}^n}{n} \quad (2)$$

Then, this matrix is normalized by considering Equations (3)-(5).

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

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right) \quad (4)$$

$$r = max_{1 \le i \le n}\left(\sum_{j=1}^{n} u_{ij}\right) \quad (5)$$

After that, the total relationship matrix is obtained. In this process, Equations (6)-(12) are considered.

$$X_l = \begin{bmatrix} 0 & l'_{12} & \cdots & \cdots & l'_{1n} \\ l'_{21} & 0 & \cdots & \cdots & l'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ l'_{n1} & l'_{n2} & \cdots & \cdots & 0 \end{bmatrix} X_m = \begin{bmatrix} 0 & m'_{12} & \cdots & \cdots & m'_{1n} \\ m'_{21} & 0 & \cdots & \cdots & m'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ m'_{n1} & m'_{n2} & \cdots & \cdots & 0 \end{bmatrix} X_u = \begin{bmatrix} 0 & u'_{12} & \cdots & \cdots & u'_{1n} \\ u'_{21} & 0 & \cdots & \cdots & u'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ u'_{n1} & u'_{n2} & \cdots & \cdots & 0 \end{bmatrix} \quad (6)$$

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

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

$$\tilde{t}_{ij} = \left(l''_{ij}, m''_{ij}, u''_{ij}\right) \quad (9)$$

$$\left[l''_{ij}\right] = X_l \times (I - X_l)^{-1} \quad (10)$$

$$\left[m''_{ij}\right] = X_m \times (I - X_m)^{-1} \quad (11)$$

$$\left[u''_{ij}\right] = X_u \times (I - X_u)^{-1} \quad (12)$$

In the next process, the defuzzification process is applied. In this framework, Equations (13)-(21) are used.

$$u_i^{max} = max u_i, l_i^{min} = \min_j l_i \quad (13)$$

$$\Delta_{min}^{max} = u_i^{max} - l_i^{min} \quad (14)$$

$$x_{lj} = \left(l_{ij} - l_i^{min}\right)/\Delta_{min}^{max} \quad (15)$$

$$x_{mj} = \left(m_{ij} - l_i^{min}\right)/\Delta_{min}^{max} \quad (16)$$

$$x_{uj} = \left(u_{ij} - l_i^{min}\right)/\Delta_{min}^{max} \quad (17)$$

$$x_j^{ls} = x_{mj}/\left(1 + x_{mj} - x_{lj}\right) \quad (18)$$

$$x_j^{rs} = x_{uj}/\left(1 + x_{uj} - x_{mj}\right) \quad (19)$$

$$x_j^{crisp} = \left[x_j^{ls}\left(1 - x_j^{ls}\right) + x_j^{rs}x_j^{rs}\right] / \left[1 - x_j^{ls} + x_j^{rs}\right] \quad (20)$$

$$f_{ij} = l_i^{min} + x_j^{crisp}\Delta_{min}^{max} \quad (21)$$

4. EMPIRICAL RESULTS AND DISCUSSION

In this study, it is aimed to determine the most important factors for the development of green banking applications in the Turkish banking sector. In this context, a comprehensive literature review is carried out and five different variables affecting this process are identified. Details of these variables are given in Table 1.

Table 1: Variable List

Variables	Supporting Literature
Government incentives (HT)	(Mir and Bhat, 2022:9); (Khairunnessa et al., 2021:10); (Bouteraa et al., 2022:13)
Diversification of Green Financial Products (YFUC)	(Julia and Kassim, 2020:729); (J. Chen et al., 2022:12); (Z. Chen et al., 2022: 9)
Legal Regulations (HD)	(Ratnasari et al., 2021:2); (Hasan et al., 2022:3751); (Kurowski et al., 2022:10)
Customer Awareness (MB)	(Rehman et al., 2021:2); (Zhang et al., 2022:8); (Boitan, 2020:41)
Innovation and Technological Development (ITG)	(Malik and Singh, 2022:5); (Sehen et al., 2022:7)

Government incentives are very important for the development of green banking activities (Mikhaylov et al., 2023). Thanks to government incentives such as low-interest loans and tax reductions, some financial advantages can be provided to green banking applications (Carayannis et al., 2023). This, in turn, helps banks develop green financial products and invest more in this area (Wan et al., 2023). Similarly, the diversification of green financial products has an important role in the development of green banking applications (Al-Binali et al., 2023). The development of new products can help meet the expectations of different customer groups more clearly (Moiseev et al., 2023). As this situation will increase the competitiveness of banks, it contributes to increasing the performance of green banking activities (Kou et al., 2023).

In addition to the mentioned issues, effective legal regulations are also very necessary for the development of green banking activities. These regulations help to set standards in green banking activities. This, in turn, increases investor confidence in green banking activities. In addition, customer awareness is of great importance in the development of green banking activities. The development of green banking activities can be carried out based on customer demands. Therefore, increasing the awareness of customers on environmental issues will positively affect the performance of green banking applications. Innovation and technological development is another variable that increases the performance of green banking activities. Innovation and technological development help develop innovative products and services to improve green banking activities.

In this study, it is aimed to determine which of the five different variables in Table 1 is more important in the development of green banking practices in Turkey. In this context, an analysis is carried out with the fuzzy DEMATEL method. First, these variables are compared with each other and made into a question. These questions are also asked to experts and their

opinions are taken. In the analysis process of the study, an expert team consisting of three people is developed. One of these experts is an academic who has important studies on green banking. The other two experts consist of senior managers in the sustainability departments of banks. All three experts have more than 20 years of work experience on the subject. These questions are asked to these people and they were asked to answer with a five-point scale. Details of these expert opinions are given in Table 2.

Table 2: Expert Opinions

Expert 1					
	DT	YFUC	HD	MB	ITG
DT	0	2	2	2	3
YFUC	4	0	4	5	5
HD	3	2	0	2	2
MB	2	2	1	0	2
ITG	2	1	3	3	0
Expert 2					
	DT	YFUC	HD	MB	ITG
DT	0	2	1	2	2
YFUC	5	0	5	4	5
HD	2	2	0	1	2
MB	2	2	1	0	2
ITG	2	1	2	3	0
Expert 3					
	DT	YFUC	HD	MB	ITG
DT	0	1	2	2	3
YFUC	5	0	5	5	5
HD	2	2	0	1	2
MB	1	1	1	0	2
ITG	2	1	2	2	0

After that, the relevant expert opinions are translated into triangular fuzzy numbers. In this process, the values in Table 3 are considered.

Table 3: Fuzzy Number Equivalents

Scales	Triangular Fuzzy Number Equivalents		
1	0,00	0,00	0,25
2	0,00	0,25	0,50
3	0,25	0,50	0,75
4	0,50	0,75	1,00
5	0,75	1,00	1,00

Thus, triangular fuzzy number equivalents of expert opinions can be obtained as in Table 4.

Table 4: Fuzzy Number Equivalents of Expert Opinions

Expert 1															
	DT			YFUC			HD			MB			ITG		
DT	0,00	0,00	0,00	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,25	0,50	0,25	0,50	0,75
YFUC	0,50	0,75	1,00	0,00	0,00	0,00	0,50	0,75	1,00	0,75	1,00	1,00	0,75	1,00	1,00
HD	0,25	0,50	0,75	0,00	0,25	0,50	0,00	0,00	0,00	0,00	0,25	0,50	0,00	0,25	0,50
MB	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,00	0,25	0,00	0,00	0,00	0,00	0,25	0,50
ITG	0,00	0,25	0,50	0,00	0,00	0,25	0,25	0,50	0,75	0,25	0,50	0,75	0,00	0,00	0,00
Expert 2															
	DT			YFUC			HD			MB			ITG		
DT	0,00	0,00	0,00	0,00	0,25	0,50	0,00	0,00	0,25	0,00	0,25	0,50	0,00	0,25	0,50
YFUC	0,75	1,00	1,00	0,00	0,00	0,00	0,75	1,00	1,00	0,50	0,75	1,00	0,75	1,00	1,00
HD	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,00	0,00	0,00	0,00	0,25	0,00	0,25	0,50
MB	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,00	0,25	0,00	0,00	0,00	0,00	0,25	0,50
ITG	0,00	0,25	0,50	0,00	0,00	0,25	0,00	0,25	0,50	0,25	0,50	0,75	0,00	0,00	0,00
Expert 3															
	DT			YFUC			HD			MB			ITG		
DT	0,00	0,00	0,00	0,00	0,00	0,25	0,00	0,25	0,50	0,00	0,25	0,50	0,25	0,50	0,75
YFUC	0,75	1,00	1,00	0,00	0,00	0,00	0,75	1,00	1,00	0,75	1,00	1,00	0,75	1,00	1,00
HD	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,00	0,00	0,00	0,00	0,25	0,00	0,25	0,50
MB	0,00	0,00	0,25	0,00	0,00	0,25	0,00	0,00	0,25	0,00	0,00	0,00	0,00	0,25	0,50
ITG	0,00	0,25	0,50	0,00	0,00	0,25	0,00	0,25	0,50	0,00	0,25	0,50	0,00	0,00	0,00

Then, the direct relationship matrix was obtained by taking the average value of the expert opinions. The details of this matrix are given in Table 5.

Table 5: Direct Relationship Matrix

	DT			YFUC			HD			MB			ITG		
DT	0,00	0,00	0,00	0,00	0,17	0,42	0,00	0,17	0,42	0,00	0,25	0,50	0,17	0,42	0,67
YFUC	0,67	0,92	1,00	0,00	0,00	0,00	0,67	0,92	1,00	0,67	0,92	1,00	0,75	1,00	1,00
HD	0,08	0,33	0,58	0,00	0,25	0,50	0,00	0,00	0,00	0,00	0,08	0,33	0,00	0,25	0,50
MB	0,00	0,17	0,42	0,00	0,17	0,42	0,00	0,00	0,25	0,00	0,00	0,00	0,00	0,25	0,50
ITG	0,00	0,25	0,50	0,00	0,00	0,25	0,08	0,33	0,58	0,17	0,42	0,67	0,00	0,00	0,00

Then, the "r" values, which represent the sum of the "u" values in all rows, are calculated. Table 6 shows the details of the r values for each criterion.

Table 6: "r" Values of Variables

Variables	r Values
DT	2,00
YFUC	4,00
HD	1,92
MB	1,58
ITG	2,00

As can be seen from Table 6, the largest "r" value is determined as "4.00" belonging to the second row. In the following process of the analysis, each value in the direct relationship matrix is divided by the number "4.00" and the values are normalized. The details of the normalized matrix are given in Table 7.

Table 7: Normalized Matrix

	DT			YFUC			HD			MB			ITG		
DT	0,00	0,00	0,00	0,00	0,04	0,10	0,00	0,04	0,10	0,00	0,06	0,13	0,04	0,10	0,17
YFUC	0,17	0,23	0,25	0,00	0,00	0,00	0,17	0,23	0,25	0,17	0,23	0,25	0,19	0,25	0,25
HD	0,02	0,08	0,15	0,00	0,06	0,13	0,00	0,00	0,00	0,00	0,02	0,08	0,00	0,06	0,13
MB	0,00	0,04	0,10	0,00	0,04	0,10	0,00	0,00	0,06	0,00	0,00	0,00	0,00	0,06	0,13
ITG	0,00	0,06	0,13	0,00	0,00	0,06	0,02	0,08	0,15	0,04	0,10	0,17	0,00	0,00	0,00

In the next step, the normalized matrix in Table 7 is divided into three parts according to "l", "m" and "u" values. The resulting split matrices are shown in Table 8.

Table 8: Split Normalized Matrices

Normalized Direct Relationship Matrix (Xl)					
	DT	YFUC	HD	MB	ITG
DT	0,00	0,00	0,00	0,00	0,04
YFUC	0,17	0,00	0,17	0,17	0,19
HD	0,02	0,00	0,00	0,00	0,00
MB	0,00	0,00	0,00	0,00	0,00
ITG	0,00	0,00	0,02	0,04	0,00
Normalized Direct Relationship Matrix (Xm)					
	DT	YFUC	HD	MB	ITG
DT	0,00	0,04	0,04	0,06	0,10
YFUC	0,23	0,00	0,23	0,23	0,25
HD	0,08	0,06	0,00	0,02	0,06
MB	0,04	0,04	0,00	0,00	0,06
ITG	0,06	0,00	0,08	0,10	0,00
Normalized Direct Relationship Matrix (Xu)					
	DT	YFUC	HD	MB	ITG
DT	0,00	0,10	0,10	0,13	0,17
YFUC	0,25	0,00	0,25	0,25	0,25
HD	0,15	0,13	0,00	0,08	0,13
MB	0,10	0,10	0,06	0,00	0,13
ITG	0,13	0,06	0,15	0,17	0,00

Then, the values in the split normalized matrices are subtracted from the unit matrix (I). The values of these differences are given in Table 9.

Table 9: Difference Matrices

Difference Matrix (I-Xl)					
	DT	YFUC	HD	MB	ITG
DT	1,00	0,00	0,00	0,00	-0,04
YFUC	-0,17	1,00	-0,17	-0,17	-0,19
HD	-0,02	0,00	1,00	0,00	0,00
MB	0,00	0,00	0,00	1,00	0,00
ITG	0,00	0,00	-0,02	-0,04	1,00
Difference Matrix (I-Xm)					
	DT	YFUC	HD	MB	ITG
DT	1,00	-0,04	-0,04	-0,06	-0,10
YFUC	-0,23	1,00	-0,23	-0,23	-0,25
HD	-0,08	-0,06	1,00	-0,02	-0,06
MB	-0,04	-0,04	0,00	1,00	-0,06
ITG	-0,06	0,00	-0,08	-0,10	1,00
Difference Matrix (I-Xu)					
	DT	YFUC	HD	MB	ITG
DT	1,00	-0,10	-0,10	-0,13	-0,17
YFUC	-0,25	1,00	-0,25	-0,25	-0,25
HD	-0,15	-0,13	1,00	-0,08	-0,13
MB	-0,10	-0,10	-0,06	1,00	-0,13
ITG	-0,13	-0,06	-0,15	-0,17	1,00

In the next step, inverse values are computed. These new matrices obtained are shown in Table 10.

Table 10: Inverse Matrices

Inverse Matrix (I-Xl)					
	DT	YFUC	HD	MB	ITG
DT	1,00	0,00	0,00	0,00	0,04
YFUC	0,17	1,00	0,17	0,17	0,19
HD	0,02	0,00	1,00	0,00	0,00
MB	0,00	0,00	0,00	1,00	0,00
ITG	0,00	0,00	0,02	0,04	1,00
Inverse Matrix (I-Xm)					
	DT	YFUC	HD	MB	ITG
DT	1,03	0,05	0,07	0,09	0,13
YFUC	0,29	1,04	0,28	0,30	0,33
HD	0,11	0,07	1,03	0,05	0,10
MB	0,06	0,05	0,02	1,02	0,08
ITG	0,08	0,01	0,09	0,12	1,02
Inverse Matrix (I-Xu)					
	DT	YFUC	HD	MB	ITG
DT	1,15	0,19	0,23	0,26	0,30
YFUC	0,47	1,18	0,45	0,47	0,49
HD	0,28	0,21	1,13	0,23	0,27
MB	0,22	0,18	0,17	1,13	0,24
ITG	0,25	0,16	0,25	0,28	1,15

By multiplying the normalized matrices with the inverse matrices, total relationship matrices are obtained. These matrices are expressed in Table 11.

Table 11: Total Relationship Matrices

Total Relationship Matrix (Xl)					
	DT	YFUC	HD	MB	ITG
DT	0,00	0,00	0,00	0,00	0,04
YFUC	0,17	0,00	0,17	0,17	0,19
HD	0,02	0,00	0,00	0,00	0,00
MB	0,00	0,00	0,00	0,00	0,00
ITG	0,00	0,00	0,02	0,04	0,00
Total Relationship Matrix (Xm)					
	DT	YFUC	HD	MB	ITG
DT	0,03	0,05	0,07	0,09	0,13
YFUC	0,29	0,04	0,28	0,30	0,33
HD	0,11	0,07	0,03	0,05	0,10
MB	0,06	0,05	0,02	0,02	0,08
ITG	0,08	0,01	0,09	0,12	0,02
Total Relationship Matrix (Xu)					
	DT	YFUC	HD	MB	ITG
DT	0,15	0,19	0,23	0,26	0,30
YFUC	0,47	0,18	0,45	0,47	0,49
HD	0,28	0,21	0,13	0,23	0,27
MB	0,22	0,18	0,17	0,13	0,24
ITG	0,25	0,16	0,25	0,28	0,15

Table 12 includes the combined aggregate relationship matrix.

Table 12: Combined Total Relationship Matrix

	DT			YFUC			HD			MB			ITG		
DT	0,00	0,03	0,15	0,00	0,05	0,19	0,00	0,07	0,23	0,00	0,09	0,26	0,04	0,13	0,30
YFUC	0,17	0,29	0,47	0,00	0,04	0,18	0,17	0,28	0,45	0,17	0,30	0,47	0,19	0,33	0,49
HD	0,02	0,11	0,28	0,00	0,07	0,21	0,00	0,03	0,13	0,00	0,05	0,23	0,00	0,10	0,27
MB	0,00	0,06	0,22	0,00	0,05	0,18	0,00	0,02	0,17	0,00	0,02	0,13	0,00	0,08	0,24
ITG	0,00	0,08	0,25	0,00	0,01	0,16	0,02	0,09	0,25	0,04	0,12	0,28	0,00	0,02	0,15

In the next phase of the analysis, defuzzification steps are applied. This refers to the conversion of triangular fuzzy values to normal values. In this process, firstly, "ui max", "li min" and "delta" values are calculated for each row. The details of these values are given in Table 13.

Table 13: "ui max", "li min" and "delta" values

ui max	li min	delta
0,301	0,000	0,301
0,490	0,000	0,490
0,275	0,000	0,275
0,243	0,000	0,243
0,283	0,000	0,283

The x(lj), x(mj) and x(uj) values are then calculated, and the results are presented in Table 14.

Table 14: x(lj), x(mj) and x(uj) values

DT			YFUC			HD			MB			ITG		
x(lj)	x(mj)	x(uj)	x(lj)	x(mj)	x(uj)	x(lj)	x(mj)	x(uj)	x(lj)	x(mj)	x(uj)	x(lj)	x(mj)	x(uj)
0,000	0,096	0,487	0,000	0,169	0,645	0,003	0,217	0,758	0,006	0,302	0,868	0,139	0,431	1,000
0,347	0,602	0,963	0,000	0,086	0,378	0,348	0,568	0,911	0,357	0,606	0,968	0,397	0,668	1,000
0,076	0,401	1,000	0,000	0,258	0,766	0,000	0,105	0,489	0,000	0,199	0,822	0,003	0,352	0,976
0,000	0,248	0,894	0,000	0,191	0,728	0,000	0,083	0,711	0,000	0,097	0,520	0,000	0,342	1,000
0,002	0,282	0,880	0,000	0,049	0,560	0,074	0,325	0,886	0,147	0,413	1,000	0,000	0,088	0,523

In addition, x(ls), x(rs) and xj(crisp) values are calculated as in Table 15.

Table 15: x(ls), x(rs) and xj(crisp) values

DT			YFUC			HD			MB			ITG		
x(ls)	x(rs)	xj(crisp)	x(ls)	x(rs)	xj(crisp)	x(ls)	x(rs)	xj(crisp)	x(ls)	x(rs)	xj(crisp)	x(ls)	x(rs)	xj(crisp)
0,088	0,350	0,161	0,144	0,437	0,243	0,179	0,492	0,296	0,233	0,554	0,368	0,334	0,637	0,482
0,480	0,707	0,611	0,079	0,292	0,130	0,466	0,678	0,585	0,485	0,711	0,616	0,526	0,751	0,663
0,303	0,625	0,455	0,205	0,508	0,323	0,095	0,354	0,168	0,166	0,507	0,295	0,261	0,601	0,414
0,199	0,543	0,338	0,161	0,474	0,274	0,076	0,437	0,192	0,088	0,365	0,167	0,255	0,603	0,411
0,220	0,551	0,357	0,047	0,371	0,138	0,260	0,567	0,393	0,326	0,630	0,473	0,081	0,364	0,161

After that, the defuzzified aggregate relationship matrix is obtained. Details of this matrix are given in Table 16.

Table 16: Defuzzified Total Relationship Matrix

	DT	YFUC	HD	MB	ITG
DT	0,048	0,073	0,089	0,111	0,145
YFUC	0,299	0,064	0,287	0,302	0,325
HD	0,125	0,089	0,046	0,081	0,114
MB	0,082	0,066	0,047	0,041	0,100
ITG	0,101	0,039	0,111	0,134	0,046

By using the values in Table 16, both criterion weights and causality relationships between criteria can be calculated. In this framework, first, the row and column sums (Di and Ri) of this matrix are calculated. By using the sum of these values, the importance weights of the variables can be determined. Details of these values are given in Table 17.

Table 17: Criterion Weights

Variables	Di	Ri	Di+Ri	Di-Ri	Weights
DT	0,466	0,656	1,122	-0,190	0,18925
YFUC	1,277	0,331	1,608	0,945	0,27124
HD	0,456	0,580	1,035	-0,124	0,17464
MB	0,335	0,668	1,003	-0,333	0,16922
ITG	0,431	0,729	1,160	-0,299	0,19565

As can be seen from Table 17, the diversification of green financial products is the most important variable for the development of green banking practices in Turkey because it has the highest weight of importance (0,27124). Government incentives and legal regulations are other variables that should be considered in this process. Diversification of green financial products enables better responsiveness to the needs of customers in different sectors. This situation may attract the attention of investors and thus it will be possible to increase the performance of green banking activities.

5. CONCLUSION

In this study, it is aimed to determine the issues that are important for the development of green banking practices in Turkey. In this context, as a result of the literature review, five different factors that could be effective on the development of green banking activities were determined. After that, an analysis was carried out with the fuzzy DEMATEL method to determine the importance weights of these criteria. According to the results of the analysis, the diversification of green financial products is the most important variable for the development of green banking applications in Turkey. Government incentives and legal regulations are other variables that should be considered in this process. In addition to these, the diversification of green financial products is effective on all other criteria. In other words, if banks diversify their green financial products, there may be improvements in other variables. This shows that the criterion of diversification of green financial products is a very important variable.

Considering the analysis results of the study, banks should first diversify green financial products in order to develop green banking practices in Turkey. This situation primarily helps banks reach wider audiences. This situation helps to meet the expectations of different customer groups more easily. This mentioned point will support customer satisfaction. Customers with increased satisfaction prefer banks more. This situation allows both the development of green banking activities and the increase in the profitability of banks. On the other hand, increasing the number of green financial products also helps banks to spread risks. The efficiency of banks that manage their risks more effectively can also be increased. This gives banks a significant competitive advantage. This point is also emphasized in many different studies in the important literature. Akomea-Frimpong et al. (2022), Barua and Aziz (2022), and Debrah et al. (2022) analyzed different country groups in their study and emphasized that green product diversity should be increased in order to develop green finance.

It is possible to develop different environmentally friendly products according to different investor and customer types. In this framework, primarily, banks should offer loans to finance projects related to environmental sustainability. Providing financial support to renewable energy projects and investments aiming to increase energy efficiency are issues that can be considered in terms of “green loans” (Mirovic et al., 2023:4; Huang et al., 2022:5). In addition to the mentioned issues, "green credit cards" can be shown as an example of financial products that banks in Turkey can develop to increase their green banking activities. These credit cards are mainly designed to encourage eco-friendly shopping. Some of the shopping amounts to be made with these cards can be donated to support environmental activities (Zhu and Li, 2022: 1311; Narain, 2023: 2). In addition, offering low-interest loans for electric vehicles is another financial product that can be considered within the scope of green banking activities. Thanks to this loan facility, it will be possible to increase the use of vehicles that do not cause carbon emissions (Li et al., 2021: 1006; Freebairn, 2022: 4).

The biggest contribution of this study to the literature is the determination of more effective strategies for the development of green banking activities. In this way, it is possible to develop green banking activities more effectively. On the other hand, since the DEMATEL

method is preferred in calculating the weights of the criteria, the causality relationship between the variables can also be determined. This contributes to achieving more effective and accurate results. The Turkish banking sector was considered in the analysis process of the study. The findings obtained by examining one of the seven largest developing countries will also serve as a guide for other developing countries. This is also one of the important limitations of the study. Therefore, other countries or groups of countries may be considered in future studies. For example, thanks to the studies on developed countries, strategies can be developed for these economies. In addition, by making a comparative analysis of the results to be obtained, it will be possible to understand what changes for different country groups. On the other hand, it is possible to make improvements on the model developed in the study. In this context, the DEMATEL technique can be considered with different fuzzy numbers such as spherical and Pythagorean.

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