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# AN ANALYSIS OF CLIMATE CHANGE PERFORMANCES OF THE G-20 COUNTRIES

# G-20 ÜLKELERİNİN İKLİM DEĞİŞİKLİĞİ PERFORMANSLARI ÜZERİNE BİR ANALİZ

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**ABSTRACT:** The aim of this study was to examine the activities associated with climate change before and during the COVID-19 pandemic based on G-20 countries. The climate change performances of the G-20 countries were considered within the framework of four criteria (greenhouse gas emissions, renewable energy, energy usage, and climate policy). The PROMETHEE method, one of the Multi-Criteria Decision-Making (MCDM) methods, was employed for the analysis. The weights of the criteria were calculated with the MEREC method. Climate change performances of countries have changed during the pandemic process. The UK showed the best performance before and during the pandemic. Consequently, in this study, it was aimed to raise awareness by emphasizing climate change, which is one of the crucial problems of the age. Thus, an idea was obtained about the extent to which the countries implemented their climate change policies and activities during a crisis such as the COVID-19 pandemic.

***Keywords: Climate Change, Performance, MCDM, MEREC, PROMETHEE.***

**ÖZ:** Bu çalışmanın amacı, G-20 ülkelerinin pandemi öncesi ve sürecinde iklim değişikliği ile ilgili yapılan faaliyetlerin ülkeler bazında incelenmesidir. G-20 ülkelerinin iklim değişikliği performansları dört kriter (sera gazı emisyonları, yenilenebilir enerji, enerji kullanımı, iklim politikası) çerçevesinde değerlendirilmiştir. Analiz için Çok Kriterli Karar Verme (ÇKKV) yöntemlerinden PROMETHEE yöntemi kullanılmıştır. Kriterlerin ağırlıkları MEREC yöntemi ile hesaplanmıştır. Ülkelerin iklim değişikliği performalarının pandemi öncesi ve sürecinde çoğunlukla değişiklik gösterdiği görülürken; her iki dönemde de en iyi performansı Birleşik Krallık göstermiştir. Sonuç olarak bu çalışmada çağın en önemli sorunlarından biri olan iklim değişikliğine vurgu yapılarak farkındalık yaratılması amaçlanmıştır. Böylece ülkelerin, COVID-19 salgını gibi bir kriz sırasında iklim değişikliği politikalarını ve faaliyetlerini ne ölçüde hayata geçirdikleri hakkında fikir sahibi olunmuştur.

***Anahtar Kelimeler*** : ***İklim Değişikliği, Performans, ÇKKV, MEREC, PROMETHEE***

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# GENİŞLETİLMİŞ ÖZET

**Çalışmanın Amacı**

Günümüzün en önemli sorunlarından biri iklim değişikliğidir. İklim değişikliğinde yaşanan değişimler coğrafi dengeyi bozmaktadır ve küresel bir problem olarak karşımıza çıkmaktadır. İklim değişikliğinin çevresel, sosyal ve ekonomik olarak birçok alanda hayatı olumsuz etkileyeceği düşünülmektedir. Birçok ülke iklim değişikliği ile ilgili tedbirler almaktadır. Aynı zamanda alınan tedbirler sürecine iklim politikaları da dahil edilerek olası zararları azaltmak için çaba gösterilmektedir. Özellikle COVID-19 pandemi sürecinde iklim değişikliği araştırmacılar tarafından ilgi görmüştür. Bu çalışmanın amacı, pandemi öncesi ve sürecinde iklim değişikliği ile ilgili yapılan faaliyetlerin ülkeler bazında incelenmesidir.

**Araştırma Soruları**

Bu çalışmada G-20 ülkelerinin iklim değişikliği performansları değerlendirilmektedir. Özellikle COVID-19 pandemisi sürecinde iklim değişikliği ile ilgili gelişmelerin yanı sıra G-20 ülkelerinin pandemi öncesi ve pandemi sırasında ilgili politikaları ne ölçüde takip ettikleri tespit edilmeye çalışılmaktadır. Aynı zamanda Türkiye'nin iklim değişikliği alanındaki performansını diğer G-20 ülkeleriyle karşılaştırmak da mümkün olacaktır. Pandemi öncesinde ve salgın sırasında en iyi performansı gösteren ülkelerin uyguladıkları politikalar ve performanslarını iyileştirecek stratejilerin neler olduğu üzerindeki sorular cevaplanacaktır.

**Literatür Araştırması**

Huang vd. (2018), iklim değişikliğinden kaynaklanan kayıp olasılığının daha düşük ve daha değişken kazanç ve nakit akışlarıyla ilişkili olduğunu belirlemiştir. Ayrıca belirli sektörlerin aşırı hava koşullarına karşı daha az hassas olduğu ve iklim değişikliğinden daha az risk taşıdığı da tespit edilmiştir. Kılıç ve Kuzey (2019), Araştırmalarında Türkiye 'de iklim değişikliği ve uygulamalarını gönüllü olarak açıklayan banka sayısının 2010'dan 2016'ya önemli ölçüde arttığını belirtmiştir. Ayrıca banka büyüklüğünün, karlılık, banka yaşı ve listelenme durumu iklim değişikliği açıklamaları üzerinde önemli ve anlamlı etkilere sahip olduğunu belirtmiştir. Sun vd. (2020), Çinde faaliyet gösteren şirketlerde iklim değişikliği risklerine karşı farklı hassasiyetlerin olduğunu ve iklim değişikliği riskinin finansal performans üzerinde hem olumlu hem de olumsuz etkileri olduğunu gözlemlemiştir. Bunun yanında Giang ve ark. (2021), Vietnamda iklim değişikliğinin finansal performansa zarar verdiği, nem riskinin işletmenin finansal performansı ile anlamlı ve olumsuz bir ilişkisi olduğu, sıcaklık, güneş saatleri, yağış gibi doğa olaylarının finansal performans üzerinde ihmal edilebilir düzeyde etkilerinin olduğunu gözlemlemiştir. Genel olarak yapılan araştırmalara bakıldığında, iklim değişikliği birçok sektörü doğrudan veya dolaylı olarak etkilemektedir. Günümüzde sıcaklıklardaki artış devam etmekte ve doğal olarak işletmeler üzerindeki etkisini belirlemek zordur (Dell vd., 2014). IIPC'ye (2014) göre "iklim değişikliği, bu gelişmeler karşısında hem işletmelerin faaliyetlerini tehdit edebilir hem de bunları fırsata dönüştürebilir".

**Methodology**

Analiz için, birden çok kriterin ve alternatiflerin eş zamanlı çözüm sürecine dahil ederek alternatiflerin sıralanmasına imkan sunan ÇKKV yöntemleri kullanılmıştır. Kriterlerin önem ağırlıkları MEREC yöntemi ile hesaplanmıştır. Hesaplanan kriter ağırlıkları PROMETHEE yöntemine dahil edilerek alternatiflerin sıralaması yapılmıştır.

**Results and Conclusions**

Sonuçlardan elde edilen bulgulara göre pandemi öncesi ve pandemi sırasında en iyi performans gösteren ülke İngiltere olarak belirlenmiştir. Bu bulgu, Pozitif Para ve Yeşil Merkez Bankacılığı tarafından üretilen 2021 "Yeşil Merkez Bankacılığı Skorkartı"na göre İngiltere'nin örnek liderlik ve mali politikalar kategorisinde önde gelen ülkelerden biri olmasıyla paralellik göstermektedir. Genel olarak ülkelerin iklim eylemleri, performans analizi sonuçlarıyla örtüşmektedir. Bunun yanında pandemi öncesinde ve sırasında "İklim Politikası" kriterinin en önemli kriter ağırlığına sahip tespit edilmiştir. Bu sonuca dayanarak ülkelerin iklim eylem ve politikalarında daha fazla çaba göstermesi gerektiği düşünülmektedir. İklim değişikliği politika planlarında kullanılan mali fonların ise doğru yönlendirilmesinin hedeflerin gerçekleştirilmesine önemli katkı sağlayacağı düşünülmektedir.

# 1. INTRODUCTION

Along with the development of global technology, climate change has become an escalating problem. Heat waves, precipitation, and the accompanying rise in sea level directly affect the living conditions of individuals. Besides these adverse circumstances, diseases transmitted through water, agriculture, indirect mediators, and some other infectious diseases are indirectly affected by climate change. "*Migration, especially from rural areas to cities, urbanization, technology, industry, and changes in land use habits are also factors that enhance climate change"* (Celik et al., 2008).

Due to these environmental changes, many countries in the world have entered the process of combating climate in recent years. These countries implement policies for sustainable development to slow down climate change. By the courtesy of these policies, countries have been conducting implementation within the framework of the new climate economics. These studies have been also conducted on the use of renewable energy resources for the best energy resource usage and to raise environmental awareness. In this context, financing new energy usage is also quite important. Green finance, which is especially expressed as the financing of a sustainable green economy, conducts projects for the use of environmentally beneficial and less harmful products by many financial institutions. Funding these projects is the most important factor in the combat against climate change (Kuloglu & Oncel, 2015).

Central banks of developing countries and G-20 countries have also begun to play an important role by addressing the need for green investment within the scope of combating climate change. National development banks of developing countries such as Korea, Brazil, and China play important roles in making contributions. Central banks began to concentrate more on green sector-oriented loans and intensified their policy strategies in that area ("*Green Central Banking*", n.d.).

Pandemics have a very close relationship with globalization, technological developments, and climate crisis. With the COVID-19 pandemic, the impacts of climate change on countries have been a matter of curiosity. Infectious diseases, which may pose a global pandemic threat in the future, are expected to emerge more with the impact of climate change and to spread more rapidly with the influence of globalization (Daglar Macar & Asal, 2020).

Climate change continues to maintain its importance by coming to order again along with the COVID-19 pandemic. Many countries take some responsibilities to combat climate during the pandemic period. It is predicted that climate change would continue to be a global problem concerning all countries. One of the regions expected to be most affected by climate change is Türkiye, located in the Mediterranean Basin. It is estimated that the drought would be felt in large regions and the number of hot days may increase in the future in Türkiye. Therefore, it is seen that this problem should be handled meticulously in the national sense ("*T.C. Tarım ve Orman Bakanlığı",* n.d.).

The climate change performances of the G-20 countries are assessed in this study. It is tried to determine the developments associated with climate change, especially during the COVID-19 pandemic process, as well as the extent to which the G-20 countries followed related policies before and during the pandemic. At the same time, it would be possible to compare Türkiye's performance in the field of climate change with the other G-20 countries. The policies implemented by the countries with the best performance before and during the pandemic, as well as the strategies through which they improve their performances are determined. For the analysis, PROMETHEE, one of the MCDM methods, is preferred in terms of evaluating the alternatives by including multiple criteria in the simultaneous solution process. As a result of the analysis, the G-20 countries are to be ranked by their climate change performances.

## 2. THEORETICAL BACKGROUND

In the last decade, deforestation and increased greenhouse gas emissions due to uncontrolled anthropogenic activities have caused various changes in complex climate dynamics around the world, resulting in some imbalances in the environment. To give an example of this situation, the increases in CO2 in the atmosphere and global temperatures constitute an important example ("*IPCC*", 2014). As the world's natural capital decreases and ecosystems change in ways that negatively affect society, it will become necessary to take measures by investigating the causes of this to sustain the natural resources we benefit from. Otherwise, access to environmental resources and ecological services, many of which are strategically important and impossible to reach, will become scarce and difficult. When the restrictions imposed by this natural environment are noticed, environmental sustainability will become an essential part of the strategic management process to maintain resource-based advantages (Michalis & Stinchfield, 2010).

The Paris Agreement is basically based on the United Nations Framework Convention on Climate Change and aims to regulate the climate change regime after 2020, the expiration date of the Kyoto Protocol. After the expiration date of the Kyoto Protocol in 2020, the Paris Agreement on combating climate change came to the agenda. The Paris agreement aims to strengthen global socioeconomic resilience against the threat of climate change. The Paris Agreement is based on the United Nations Framework Convention on Climate Change. The long-term goal of the Agreement is to keep the global temperature increase as low as 2°C (about 1.5 degrees) compared to the pre-industrial period. This goal requires gradually reducing the use of fossil fuels (oil, coal) and turning to renewable energy ("TC., Çevre,Şehircilik ve İklim", n.d.). Conference of the Parties (COP) is the annual summit on climate action. COP brings together 197 countries, creating a platform where climate change and how countries will combat it are discussed ("İklim Krizi: COP26", 2021). The last summit; COP 28 took place in Dubai. In the text, which referred to "fossil fuels" for the first time in the history of climate negotiations, there was a call to "move away from fossil fuels" in order to limit the temperature increase. It was stated at the COP 28 summit that developing countries need climate finance. Although reference

is made to the financing required to adapt to the impacts of climate change, gaps regarding how adaptation financing will be scaled and its schedule remain unclear ("COP 28'de Tarihi Anlaşma", 2023).

As a result of climate change results, population growth, and economic relations, businesses have reduced anthropogenic greenhouse gas. (Emodi et al., 2019). At the same time, organizations such as the "*Intergovernmental Panel on Climate Change (IPCC)*", the "*International Energy Agency (IEA), United Nations Environment Programme (UNEP)*" anthropogenic carbon emissions should be reduced during periods of high temperature in relation to potential global warming. The intergovernmental panel on climate change stated that "*a portfolio and mix of strategies that includes mitigation, adaptation, technological development (both adapting and enhancing mitigation) and research*" across multiple regions will be invaluable in reducing the risks of climate change to humanity ("*IPCC*", 2007). In this context, businesses need to be proactive in the decisions regarding climate change "*due to the large amounts of carbon dioxide, greenhouse gases, and other toxins they release into the world's atmosphere (Lovins et al., 2007).*" In support of this situation, management scientists argue that businesses should change their current business practices to sustain the planet's natural resources and ecological systems (Gladwin et al., 1995; Porter & Reinhardt, 2007).

"*Climate change, will have a significant impact on reducing future growth potential the economy by negatively affecting labor productivity and diverting existing resources from productivity capital investment and innovation to climate change adaptation" ("NGFS", 2018).* Moreover, the IMF (2018) stated that investors and financial markets related to climate change could not foresee that it would affect production or productivity. Climate change affects economic events in many ways; "*decreased agricultural productivity, reduced productivity of workers exposed to increased temperatures, increased health care costs, physical destruction due to fires, floods, and rising sea levels, and loss of biodiversity can be listed as. At the same time, the role of climate change in economic growth, public debt and financing costs, employment, and inflation is undeniably high*". The practices introduced due to climate change endanger macroeconomic and financial stability by increasing the number of subsidies necessary for the economy and social welfare. "*Such developments will lead to an increase in the prices of products and services such as agricultural products, insurance, and water*" (Fabris, 2020).

Measuring the impact of climate change, the risks that may arise for investors or regulators, or the opportunities for businesses is a serious challenge. The first of these difficulties stem from the fact that the impact of climate change on businesses is highly uncertain. This is because it is uncertain how the climate will eventually change, whether the regulations will be tightened concerning the change, and how and when the measures will be tightened remains unclear (Barnett et al., 2020). The second challenge arises because the impacts of climate change are very different for various businesses, even within the same industry. This is because large enterprises apply more intensively the features of

adapting to the green economy (managerial skill, innovation, or financial constraints) (Sautner et al., 2021).

Although the importance of climate change has increased, it is not known what risks will arise as a result of this, and what measures should be taken to explain or reduce the risks. Instead, scientific interest emphasizes participating in voluntary entrepreneurship and disclosing greenhouse gas emissions (Jira & Toffel, 2013; Matisoff, 2013). Clearly, the carbon footprint and climate-related procedures of businesses and the negative effects of the business from climate change risks are different from each other. For example, after Hurricane Katrina, many chemical businesses lost earnings due to increased energy costs and damage to manufacturing facilities (Reisch, 2005). In particular, climate risks include "*physical risks (such as flooding, severe storms, drought, or extreme heat), regulatory risks arising from current and anticipated government policies related to climate change (such as energy efficiency standards, carbon trading schemes), other climate-related risks (such as changing consumer behavior and increasing demands)*" can bring business activities to a standstill (Flammer et al., 2021).

## 3. LITERATURE REVIEW

With the consequences of climate change becoming more observable, the effect of climate change on the financial performance of businesses has also attracted the attention of researchers, and research has been focused on this issue.

Huang et al. (2018) analyzed using the "*climate risk index to determine the impact of climate change on the financial performance of publicly-traded businesses around the world."* According to the findings, it has been determined that the probability of loss from major storms, floods, heatwaves is associated with lower and more variable earnings and cash flows. It has also been found that specific sectors are less vulnerable to extreme weather conditions and have less risk from climate change.

Kılıc & Kuzey (2019) investigated the content of voluntary climate change disclosures in the Turkish banking sector and the factors that make up the content of these statements. According to the research findings, the number of banks that voluntarily disclose climate change and practices has increased significantly from 2010 to 2016. Furthermore, according to the regression analysis results, in line with the cost and legitimacy theory, it has been concluded that bank size, profitability, bank age, and listing status have essential and meaningful effects on climate change disclosures.

Sun et al. (2020) examined the impact of climate change risks on the financial performance of enterprises operating in the mining sector in China. According to the findings, mining enterprises with different resource types have various "*sensitivities to climate change risks, and the climate change risk has both positive and negative effects on financial performance."*

In their research, Giang et al. (2021) focused on examining the impact of climate change risks on the financial performance of businesses operating in the manufacturing sector in Vietnam. As a result

of the research, it has been determined that climate change hurts financial performance, humidity risk has a significant and adverse relationship with the enterprise's financial performance, and natural events such as temperature, sun hours, or precipitation have negligible effects on financial performance.

According to the research results summarized above, climate change affects many sectors directly or indirectly. Businesses operating such as *"agriculture, forestry, fishing and mining are directly affected by climate change."* Businesses operating in this sector are vulnerable to natural events. The reason for this is the interrelationship of the sectors (Sun et al., 2020). Today, the increase in temperatures continues and naturally it is difficult to determine the effect on businesses (Dell et al., 2014). According to IIPC (2014), "*climate change can both threaten businesses' activities and turn them into opportunities in the face of these developments".*

# 4.METHODOLOGY

## 4.1. MEREC Method

"*The Method based on the Removal Effects of Criteria* (*MEREC)"* method is one of the objective weighting methods introduced in the literature by Ghorabaee et al. in 2021. The MEREC method uses each criterion's removal effect on performing alternatives to determine criteria weights. The absolute deviation measure is used to determine the effects of removing each criterion. The measure used reflects the difference between the performance of the overall alternative and its performance in removing a criterion. The steps in calculating the MEREC method (Ghorabaee et al., 2021):

***Step 1: "****The first step of the MEREC method is constructing the decision matrix of the problem. The elements of the matrix are denoted by xij (Equation 1). The elements of the matrix must be greater than zero ($x_{ij}>0$). If there are negative values in the decision matrix, they should be converted to positive values using an appropriate technique*."

$$x=\begin{bmatrix} x_{11} & x_{1j} & \dots & x_{1m} \\ x_{21} & x_{2j} & \dots & x_{2m} \\ \dots & \dots & x_{ij} & \dots \\ x_{n1} & x_{nj} & \dots & x_{nm} \end{bmatrix} \qquad i = 1,2\dots,n \;\; j = 1,\dots,m \tag{1}$$

***Step 2: "****The decision matrix is normalized. A simple linear normalization is used to scale each value of the decision matrix. The elements of the normalized decision matrix are denoted by* $n_{ij}^{x}$ *β represents the set of useful criteria, H' the set of non-useful criteria, and the following equation (2) is used for the normalization process."*

$$n_{ij}^{x} = \begin{cases} \dfrac{\min x_{kj}}{x_{ij}} & \text{if,} \quad j \in \beta \\ \dfrac{x_{ij}}{\max x_{kj}} & \text{if,} \quad j \in H \end{cases} \tag{2}$$

***Step 3:*** "*The overall performance value of the alternatives is calculated. A logarithmic measure with equal criterion weights is applied to obtain the overall performances of the alternatives. This measurement is based on a nonlinear function. (Si) is obtained using the normalized values calculated in Step 2. The calculation is done by Equation (3).*"

$$S_i = \ln\left(1 + \left(\frac{1}{m}\sum_j \left|\ln(n_{ij}^{x})\right|\right)\right) \tag{3}$$

***Step 4:*** "*The performance of the alternatives is calculated by removing the value of each criterion. The difference between step 4 and step 3 is that the performances of the alternatives are calculated based on removing each criterion separately. The following Equation (4) is used for the calculation of this step.*"

$$S_i^{'} = \ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j} \left|\ln(n_{ik}^{x})\right|\right)\right) \tag{4}$$

***Step 5:*** ""*Absolute deviations totals are calculated. The removal effect of each jth criterion is obtained and Ej value denotes the effect of removing jth criterion. The following Equation (5) is used for the calculation of this step.*

$$E_j = \sum_i \left|S_{ij}^{'} - S_i\right| \tag{5}$$

***Step 6:*** "*Criteria objective weights are calculated. In this step, the final weight of each criterion is calculated using the (Ej) values obtained in step 5. Each criterion's objective weight is denoted by (Wj). The calculation is done by Equation (6).*"

$$w_j = \frac{E_j}{\sum_k E_k} \tag{6}$$

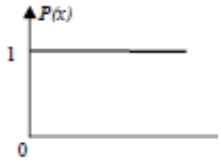
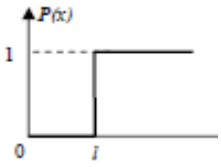
### 4.2.PROMETHEE Method

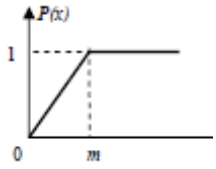
"*The Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)" method is one of the "Multiple-Criteria Decision-Making (MCDM)"* methods. It was introduced to the literature by Brans in 1982. The basic feature of the method is that it is simple and balanced. Preference index is used while ranking the alternatives in the method. This method provides a partial and total preorder of alternatives. The partial preorder is expressed as PROMETHEE I, total preorder is expressed as "*PROMETHEE II.*" The partial preorder is determined by comparing the alternatives based on criteria using the "*PROMETHEE I method*". The net priorities are determined because of the comparison of the alternatives based on criteria by using the "*PROMETHEE II method*" (Brans & Vincke, 1985). The steps in calculating the "*PROMETHEE method"* (Brans & Vicke, 1985; Dagdeviren & Eraslan, 2008).

***Step 1:*** "*The first step of the PROMETHEE method is constructing the decision matrix of the problem."*

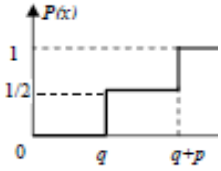
***Step 2:*** "*The preference index is determined for the criteria. The preference index to be used in the method is shown in Table 1."*

**Table 1.** Preference Index

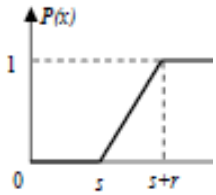
| Type | Parameters | Function | Graph, p(x) |
|---|---|---|---|
| **Type I**<br>**(Usual Criterion)** | - | $p(x) = \begin{cases} 0, \\ 1, \end{cases}$ |  |
| ***"Description:** Absence of difference the interval ($V_x \leq 0$), the existence of a complete priority of an alternative in interval ($V_x > 0$)"* | | | |
| **Type II**<br>**(Quasi-Criterion)** | *l* | $p(x) = \begin{cases} 0, \\ 1, \end{cases}$ |  |
| ***"Description:** Lack of differences in the interval ($x \leq l$), the existence of a complete priority of an alternative in interval ($x > l$)"* | | | |

| | | | |
|---|---|---|---|
| **Type III**<br>**V-shape Criterion**<br>**(Criterion Linear Preference)** | $m$ | $p(x) = \begin{cases} x/m, \\ 1, \end{cases}$ |  |

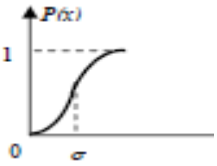
***"Description:*** *Absence of difference in the interval ($x \leq m$), the existence of a complete priority of an alternative in interval ($x > m$)"*

| | | | |
|---|---|---|---|
| **Type IV**<br>**(Level-Criterion)** | q, p | $p(x) = \begin{cases} 0, \\ 1/2, \\ 1, \end{cases}$ |  |

***"Description:*** *Lack of difference in interval ($x \leq q$), change in priority value of alternative linearly in the interval ($q < x \leq q + p$), the existence of a complete priority of an alternative in the interval ($x > q + p$)"*

| | | | |
|---|---|---|---|
| **Type V**<br>**(Criterion with Linear Preference and Indifference Area)** | s, r | $p(x) = \begin{cases} 0, \\ (x-s), \\ 1, \end{cases}$ |  |

***"Description:*** *Absence of difference in the interval ($x \leq s$), change in the priority value of alternative linearly in the interval ($s < x \leq s + r$), the existence of the full priority of an alternative in interval ($x > s + r$)"*

| | | | |
|---|---|---|---|
| **Type VI**<br>**(Gaussian Criteria)** | $\sigma$ | $p(x) = \begin{cases} 0, \\ 1-e^{-} \end{cases}$ |  |

***"Description:*** *Lack of difference in the interval ($x \leq 0$), an increase in the priority rate of alternative in the interval ($x > 0$)"*

**Source:** Brans & Vincke (1985); Alinezhad & Khalili (2019).

***Step 3:*** "*After the preference index is determined, the common preference function is determined for pair-wise comparisons of the alternatives. Equation (7) is used for the common preference function of alternatives (a) and (b).*"

$$p(a,b)=\begin{Bmatrix} 0 & , & f(a)\le f(b) \\ P\left[f(a)-f(b)\right] & , & f(a)\succ f(b) \end{Bmatrix} \tag{7}$$

***Step 4:*** **"***Preference indices are determined for each pair of alternatives. wi (i=1,2,...k) denoted the criteria weights. The preference index of (a) and (b) alternatives evaluate by the weighted k criteria is calculated by Equation (8).*"

$$\pi(a,b)=\frac{\sum_{i=1}^{k} w_i * P_i(a,b)}{\sum_{i=1}^{k} w_i} \tag{8}$$

***Step 5:*** **"***Positive (Φ+) and negative (Φ-) superiority are determined for alternatives. Equation (9) is used for positive superiority, and Equation (10) is used for negative superiority.*"

$$\Phi^{+}(a)=\sum \pi(a,x) \quad x=(a,c,d,...) \tag{9}$$

$$\Phi^{-}(a)=\sum \pi(x,a) \quad x=(b,c,d,...) \tag{10}$$

***Step 6:*** **"***A partial preorder is set with PROMETHEE I. Partial preorder enables the determination of the preference of alternatives over each other, alternatives that are indifferent to each other, and alternatives that cannot be compared with each other. The following scenarios are in question in determining the partial preorder of two alternatives, such as (a) and (b).*"

*If any of the conditions of Equations (11), (12), (13) are met; Alternative (a) is preferred to alternative (b).*

$$i=\Phi^{+}(a)\succ\Phi^{+}(b) \quad \Phi^{-}(a)\prec\Phi^{-}(b) \tag{11}$$

$$ii=\Phi^{+}(a)\succ\Phi^{+}(b) \quad \Phi^{-}(a)=\Phi^{-}(b) \tag{12}$$

$$iii=\Phi^{+}(a)=\Phi^{+}(b) \quad \Phi^{-}(a)\prec\Phi^{-}(b) \tag{13}$$

*If the condition of Equation (14) is met; Alternative (a) is indifferent to alternative (b).*

$$i=\Phi^{+}(a)=\Phi^{+}(b) \quad \Phi^{-}(a)=\Phi^{-}(b) \tag{14}$$

*If any of the conditions of Equations (15), (16) are met, alternative (a) cannot be compared with alternative (b).*

$$i.\Phi^{+}(a) \succ \Phi^{+}(b) \quad \Phi^{-}(a) \succ \Phi^{-}(b) \tag{15}$$

$$ii. = \Phi^{+}(a) \prec \Phi^{+}(b) \quad \Phi^{-}(a) \prec \Phi^{-}(b) \tag{16}$$

***Step 7:*** **"***For PROMETHEE II, the total preorder of the alternatives is calculated with Equation (17). Alternatives are ranked with the total preorder values obtained."*

$$\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a) \tag{17}$$

*Depending on the total preorder value calculated for the two alternatives, (a) and (b), the following decisions are made,*

*"If* $\Phi(a) \succ \Phi(b)$ *, alternative (a) is superior,*

*If* $\Phi(a) = \Phi(b)$ *, alternatives (a) and (b) are indifferent."*

## 5. ANALYSIS

While the coronavirus affected countries, it also showed its effect in the economic and political dimensions, especially in the field of health. These developments hurt harmed countries, especially in economic terms. The increase in cases with the spread of the epidemic led countries to seek different measures. Governments have implemented many restraint policies for precautionary purposes in this process. Leaving the house, travel restrictions, etc. These are some of them. These restrictions have changed the supply-demand balance. Especially with the decreasing demands, the production in the industry has decreased. Along with this, reductions in carbon emissions were observed. These events have greatly affected climate change, and air pollution has decreased with decreasing carbon emissions during the COVID-19 period.

While emissions, which decreased with the global epidemic, are a positive development in terms of climate action, it is known that this effect will be short-term. In this context, it is predicted that the global emission reductions will change the balances as they depend on the decrease in economic activities. Long-term plans and actions are necessary for countries not to disturb the economic balance and at the same time to continue their emission reductions. With the effect of the epidemic, it is estimated that the emission reductions seen in 2020 may be temporary. However, the countries' ability to reflect these emission reductions in the long term depends on the climate actions they will implement. In this study, the effect of the COVID-19 pandemic on climate change performances in countries was investigated. In this context, the G-20 countries were discussed. Considering four criteria that measure the climate change performances of G-20 countries; the performance of countries before and after the

pandemic was examined. Thus, in the fight of G-20 countries against climate change; their performance, especially in times of crisis, will be determined.

The four criteria determined for the study were obtained from the "*Climate Change Performance Index CCPI (https://ccpi.org/).*" CCPI conducts research on countries' fulfillment of their obligations to combat the climate crisis. CCPI, German environmental and development organization Germanwatch e.v. It is a scoring system designed by the company and aims to increase transparency in international climate policies. The criteria used in the analysis; aregreenhouse gas emission, renewable energy, energy used, and climate policies. These criteria were scored with 14 different components in total (https://ccpi.org/methodology/). While averaging the data for the years 2018-2019 for the pre-pandemic period; For the pandemic process, the average of the data for the year 2020-2021 was used.

MCDM methods were used for analysis. MCDM methods; offer a simultaneous solution by using many criteria and alternatives. MCDM methods have been preferred because they are suitable for simultaneous evaluation of the criteria selected with the G-20 countries. One of the "*MCDM methods*", the PROMETHEE method was used. The reason why the PROMETHEE method is preferred is that it is easy and applicable. At the same time, the widely preferred PROMETHEE method in the literature is to ensure reliability by using many other MCDM methods together (Wang et al., 2006; Avikal, et al., 2014; Omurbek & Eren, 2016; Genc & Masca, 2013; Jiao et al., 2011; Balusa & Singam, 2018; Apan & Öztel, 2020; Yücel & Arslan, 2021; Yaman & Koramşa, 2023).

The weights of the criteria were calculated by the MEREC method. Since the MEREC method is new, there are limited studies in the literature (Ghorabaee et al., 2021; Goswami et al., 2021; Trung & Thinh, 2021; Rani et al., 2022; Toslak et al., 2022; Ecer & Aycin, 2022; Acar Akbulut et al., (2024; Simic et al., 2024; Şeyranlıoğlu, et al., 2024). Therefore, the "*MEREC method*" has been preferred to contribute to the literature. At the same time, analysis was made with a new integrated model created by using MEREC, PROMETHEE method. The criteria used in the analysis are greenhouse gas emission % (C1), renewable energy %(C2), energy use % (C3) and climate policy % (C4).The high values in the determined criteria indicate that the performance shown in the relevant criteria is high. Therefore, all criteria are beneficial.

Two different decision matrices were created for the analysis. First, the decision matrix, which includes the criteria values of the G-20 countries for the pre-COVID-19 period, was as shown in

**Table 2.** Pre-COVID-19 Decision Matrix

| **2018/2019 Average** | **C1** | **C2** | **C3** | **C4** |
|---|---|---|---|---|
| **Australia** | 44.85 | 20.465 | 38.95 | 5.9 |
| **Argentina** | 43.95 | 17.295 | 58.7 | 68.05 |

| | | | | |
|---|---|---|---|---|
| **Brazil** | 61.75 | 54.475 | 67.3 | 42.6 |
| **Canada** | 21.83 | 20.6 | 20.75 | 58.15 |
| **China** | 37.4 | 36.25 | 40.4 | 82.95 |
| **France** | 62.5 | 27.065 | 55.2 | 85.65 |
| **Germany** | 56.6 | 39.045 | 55.1 | 69.95 |
| **India** | 71.85 | 36.115 | 73.9 | 68.65 |
| **Indonesia** | 51.2 | 29.99 | 63.25 | 37.65 |
| **Italy** | 63.05 | 37.355 | 61.4 | 56.6 |
| **Japan** | 46.3 | 22 | 54.8 | 29.7 |
| **Korea, Rep.** | 14.85 | 31.67 | 14.55 | 62.3 |
| **Mexico** | 53.5 | 19.62 | 75.5 | 57.45 |
| **Russian Federation** | 49.95 | 2.975 | 50.55 | 35.2 |
| **Saudi Arabia** | 5.7 | 14.93 | 13.35 | 37.3 |
| **South Africa** | 52.15 | 16.78 | 61.4 | 51.8 |
| **Türkiye** | 52.95 | 47.37 | 44.9 | 4.4 |
| **United States** | 22.85 | 17.9 | 28.55 | 1.4 |
| **United Kingdom** | 76.85 | 40.6 | 66.4 | 78.45 |

The second was the decision matrix in which the G-20 countries were included with their criterion values for the COVID-19 period. It was shown in Table 3.

**Table 3.** Decision Matrix in COVID-19 Period

| **2020/2021 Average** | **C1** | **C2** | **C3** | **C4** |
|---|---|---|---|---|
| **Australia** | 16.295 | 3.475 | 9.265 | 0.405 |
| **Argentina** | 18.225 | 4.995 | 14.295 | 6.26 |
| **Brazil** | 23.95 | 12.27 | 15.235 | 2.615 |
| **Canada** | 10.515 | 2.855 | 3.4 | 8.64 |
| **China** | 18.1 | 8.925 | 8.34 | 14.84 |
| **France** | 26.085 | 6.02 | 11.845 | 13.425 |
| **Germany** | 26.655 | 7.985 | 13.145 | 12.17 |
| **India** | 29.905 | 8.495 | 14.725 | 13.46 |
| **Indonesia** | 22.875 | 10.185 | 13.44 | 8.88 |
| **Italy** | 24.085 | 7.23 | 12.7 | 10.21 |

| | | | | |
|---|---|---|---|---|
| **Japan** | 21.72 | 5.505 | 12.165 | 6.12 |
| **Korea. Rep.** | 9.21 | 5.21 | 5.28 | 8.555 |
| **Mexico** | 28.055 | 2.13 | 16.285 | 5.935 |
| **Russian Federation** | 17.82 | 1.37 | 10.12 | 3.235 |
| **Saudi Arabia** | 8.085 | 4.235 | 5.76 | 5.275 |
| **South Africa** | 21.835 | 4.075 | 13.575 | 9.15 |
| **Türkiye** | 22.22 | 11.005 | 9.845 | 3.935 |
| **United States** | 13.72 | 3.16 | 6.495 | 5.465 |
| **United Kingdom** | 32.78 | 8.91 | 15.02 | 14.63 |

### 5.1.Calculate Weights Of Criteria Using MEREC Method

The criterion weights were calculated using the "*MEREC method*." First, criterion weights were calculated for the pre-COVID-19 period decision matrix. For this purpose, the decision matrix in Table.2 has been used. The decision matrix was normalized using Equation (2). The normalized decision matrix was shown in Table 4.

**Table 4.** The Normalized Decision Matrix (Pre-COVID-19)

| **2018/2019 Average** | **C1** | **C2** | **C3** | **C4** |
|---|---|---|---|---|
| **Australia** | 0.12709 | 0.14537 | 0.34275 | 0.23729 |
| **Argentina** | 0.12969 | 0.17202 | 0.22743 | 0.02057 |
| **Brazil** | 0.09231 | 0.05461 | 0.19837 | 0.03286 |
| **Canada** | 0.26111 | 0.14442 | 0.64337 | 0.02408 |
| **China** | 0.15241 | 0.08207 | 0.33045 | 0.01688 |
| **France** | 0.09120 | 0.10992 | 0.24185 | 0.01635 |
| **Germany** | 0.10071 | 0.07619 | 0.24229 | 0.02001 |
| **India** | 0.07933 | 0.08238 | 0.18065 | 0.02039 |
| **Indonesia** | 0.11133 | 0.09920 | 0.21107 | 0.03718 |
| **Italy** | 0.09040 | 0.07964 | 0.21743 | 0.02473 |
| **Japan** | 0.12311 | 0.13523 | 0.24361 | 0.04714 |
| **Korea. Rep.** | 0.38384 | 0.09394 | 0.91753 | 0.02247 |
| **Mexico** | 0.10654 | 0.15163 | 0.17682 | 0.02437 |
| **Russian Federation** | 0.11411 | 1.00000 | 0.26409 | 0.03977 |
| **Saudi Arabia** | 1.00000 | 0.19926 | 1.00000 | 0.03753 |

| | | | | |
|---|---|---|---|---|
| **South Africa** | 0.10930 | 0.17729 | 0.21743 | 0.02703 |
| **Türkiye** | 0.10765 | 0.06280 | 0.29733 | 0.31818 |
| **United States** | 0.24945 | 0.16620 | 0.46760 | 1.00000 |
| **United Kingdom** | 0.07417 | 0.07328 | 0.20105 | 0.01785 |

In the next step, the overall performances of the alternatives were calculated using the normalized decision matrix. The values got using Equation (3) were as shown in Table 5.

**Table 5.** Obtain The Overall Performances Of The Alternatives ($S_i$) (Pre-COVID-19)

| **2018/2019 Average** | **($S_i$)** |
|---|---|
| **Australia** | 0.965135 |
| **Argentina** | 1.191454 |
| **Brazil** | 1.275583 |
| **Canada** | 1.051298 |
| **China** | 1.221602 |
| **France** | 1.262426 |
| **Germany** | 1.266874 |
| **India** | 1.297075 |
| **Indonesia** | 1.205472 |
| **Italy** | 1.264064 |
| **Japan** | 1.144408 |
| **Korea. Rep.** | 1.029996 |
| **Mexico** | 1.221757 |
| **Russian Federation** | 0.98643 |
| **Saudi Arabia** | 0.799268 |
| **South Africa** | 1.184822 |
| **Türkiye** | 1.043336 |
| **United States** | 0.68602 |
| **United Kingdom** | 1.311374 |

In this step, calculate the alternatives' overall performances by removing each criterion by $S'_{ij}$ using the Equation (4) and was as shown in Table 6.

**Table 6.** The Values of $S_{ij}^{'}$ (Pre-COVID-19)

| 2018/2019 Average | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| **Australia** | 0.74642 | 0.76222 | 0.85758 | 0.81781 |
| **Argentina** | 1.02289 | 1.04796 | 1.07214 | 0.84196 |
| **Brazil** | 1.09364 | 1.04869 | 1.15574 | 1.00318 |
| **Canada** | 0.92650 | 0.86609 | 1.01200 | 0.65738 |
| **China** | 1.07238 | 1.01797 | 1.13648 | 0.86381 |
| **France** | 1.07681 | 1.09259 | 1.15661 | 0.91850 |
| **Germany** | 1.09053 | 1.06682 | 1.16169 | 0.94465 |
| **India** | 1.10693 | 1.11004 | 1.17272 | 0.98785 |
| **Indonesia** | 1.02587 | 1.01548 | 1.08161 | 0.92242 |
| **Italy** | 1.07804 | 1.06720 | 1.15004 | 0.96122 |
| **Japan** | 0.96199 | 0.97092 | 1.02516 | 0.86580 |
| **Korea. Rep.** | 0.94066 | 0.79289 | 1.02228 | 0.61637 |
| **Mexico** | 1.04146 | 1.07212 | 1.08519 | 0.90200 |
| **Russian Federation** | 0.76034 | 0.98643 | 0.85390 | 0.62888 |
| **Saudi Arabia** | 0.79927 | 0.59918 | 0.79927 | 0.33881 |
| **South Africa** | 0.99941 | 1.04296 | 1.06078 | 0.86178 |
| **Türkiye** | 0.82481 | 0.76395 | 0.93037 | 0.93703 |
| **United States** | 0.49389 | 0.42993 | 0.58543 | 0.68602 |
| **United Kingdom** | 1.11872 | 1.11773 | 1.19702 | 0.99502 |

After the ($S_{ij}^{'}$) values were obtained, the ($E_j$) values were obtained. The calculation of computing the summation of absolute deviations ($E_j$) values was got by using Equation (5) and was as shown in Table 7.

**Table 7.** The Summation of The Absolute Deviations ($E_j$) (Pre-COVID-19)

| C1 | C2 | C3 | C4 | ∑ |
|---|---|---|---|---|
| 3.22784 | 3.53723 | 1.89238 | 5.65791 | 14.31536 |

In the last step, the calculation of criterion weights was got by using Equation (6). Obtained criterion weights; C1 (0.2254), C2 (0.2470), C3 (0.1321) and C4 (0.3952).

According to the results of the analysis, the criterion with the highest importance for the pre-COVID-19 period was Climate Policy (C4). The Climate Policy criterion has the most important effect in evaluating the performance of countries with an index score of 0.3952. Then, the criteria with importance weight were obtained as C2, C1, and finally C3 respectively.

The same transactions were made using the COVID-19 period decision matrix. Criteria weights in the COVID-19 period; C1 (0.1322), C2 (0.2140), C3 (0.1730) and C4 (0.4805) were obtained.

According to the results of the analysis, the criterion with the highest importance in the COVID-19 period is the C4 Climate Policy (C4). The Climate Policy criterion, with an index score of 0.4805, has a significant impact on the evaluation of the performance of countries. Then, the criteria with importance weight were obtained as C2, C3 and finally C1 respectively.

**Figure 1.** Weight Change Graph Of Criteria Pre-COVID-19 and COVID-19 Period

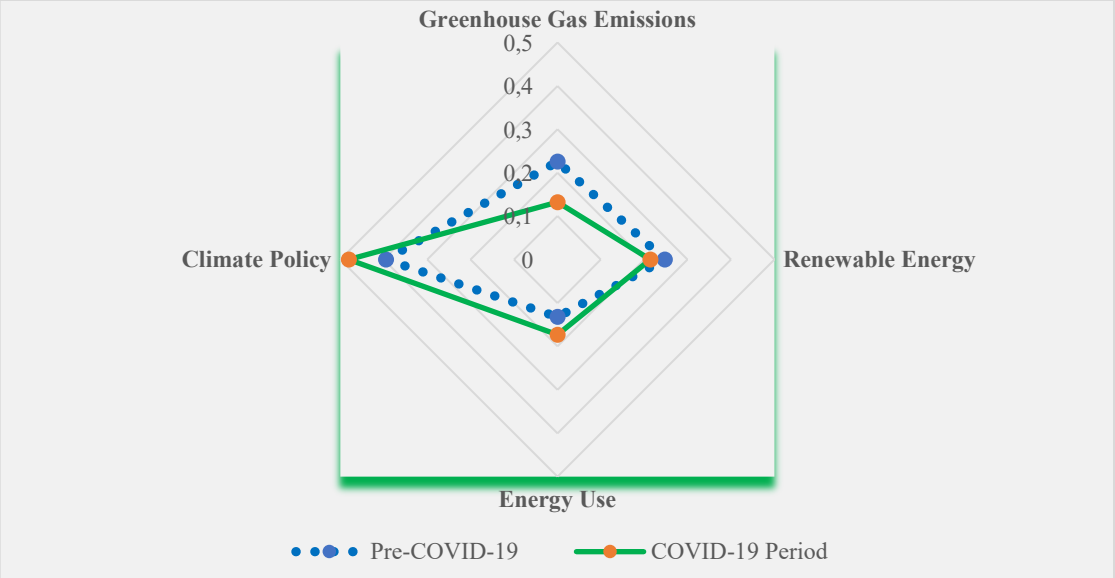


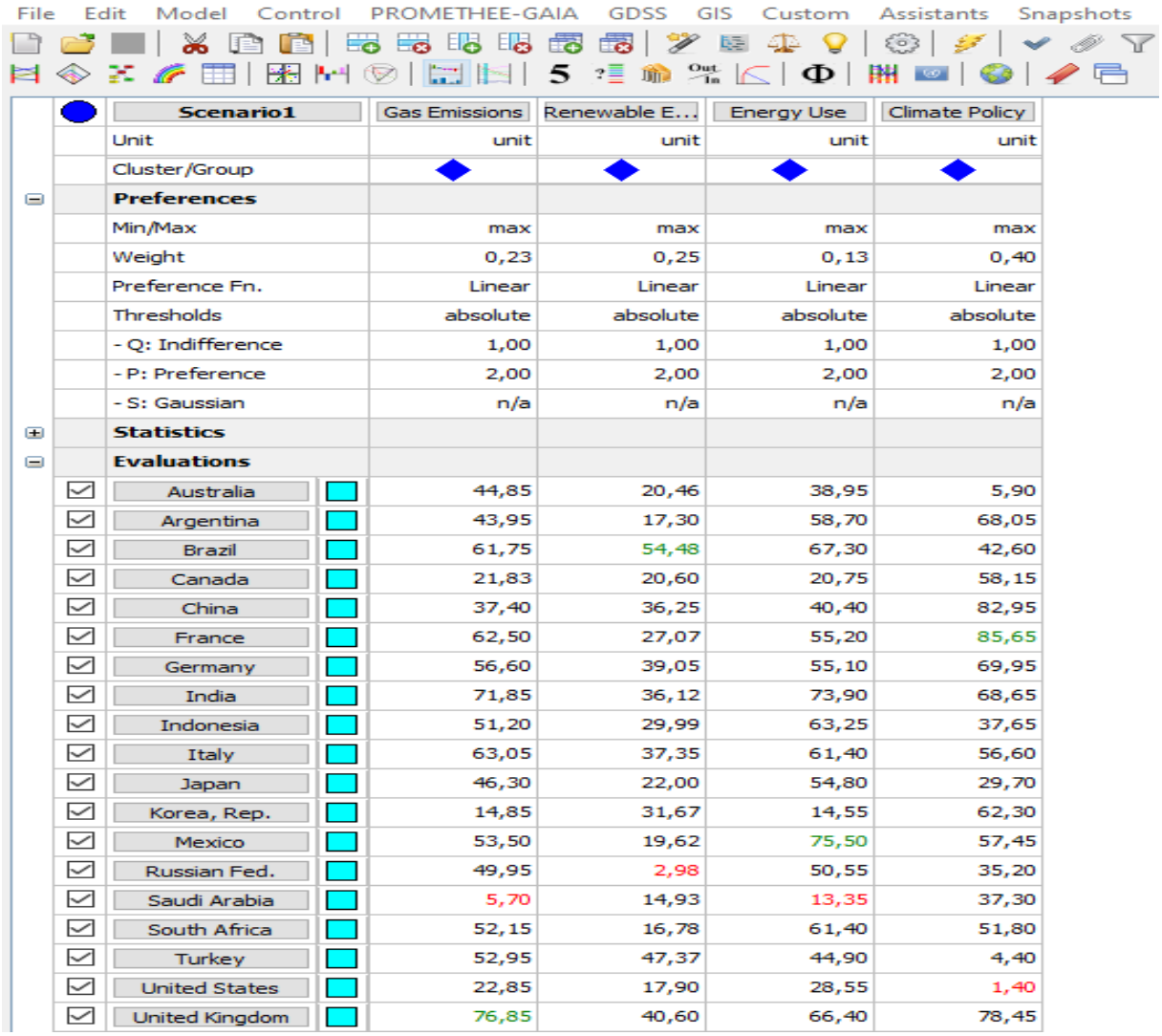

Figure 1 shows the change in criterion importance weights before and during the COVID-19 period. Changes have been observed in the weights of the performance criteria of countries under the name of climate change. The Climate policy criterion, which had the highest importance in the pre-COVID-19 period, has also been the most important in the COVID-19 period. In this process, the importance of greenhouse gas emission criteria has decreased. The energy use performance criterion has also increased in importance in the COVID-19 pandemic.

The importance weights of the criteria obtained were included in the analysis process of the PROMETHEE method and the climate change performances of the G-20 countries before and during the COVID-19 period were examined.

### 5.2. Application with MEREC Based PROMETHEE Method

G-20 countries will be ranked by using the calculated weights of criteria for the pre-COVID-19 period and the pre-COVID-19 period decision matrix in Table 2 in the PROMETHEE method. Visual *"PROMETHEE"* program was used in the implementation of the PROMETHEE method. Before applying the "*PROMETHEE method*", preference functions were determined for the criteria. In the study; Since the values of the C1, C2, C3 and C4 criteria were desired to be above a certain average, the 5th type (linear) preference function was used. The data entry screen in Figure 2 was obtained by entering the data into the Visual PROMETHEE program.

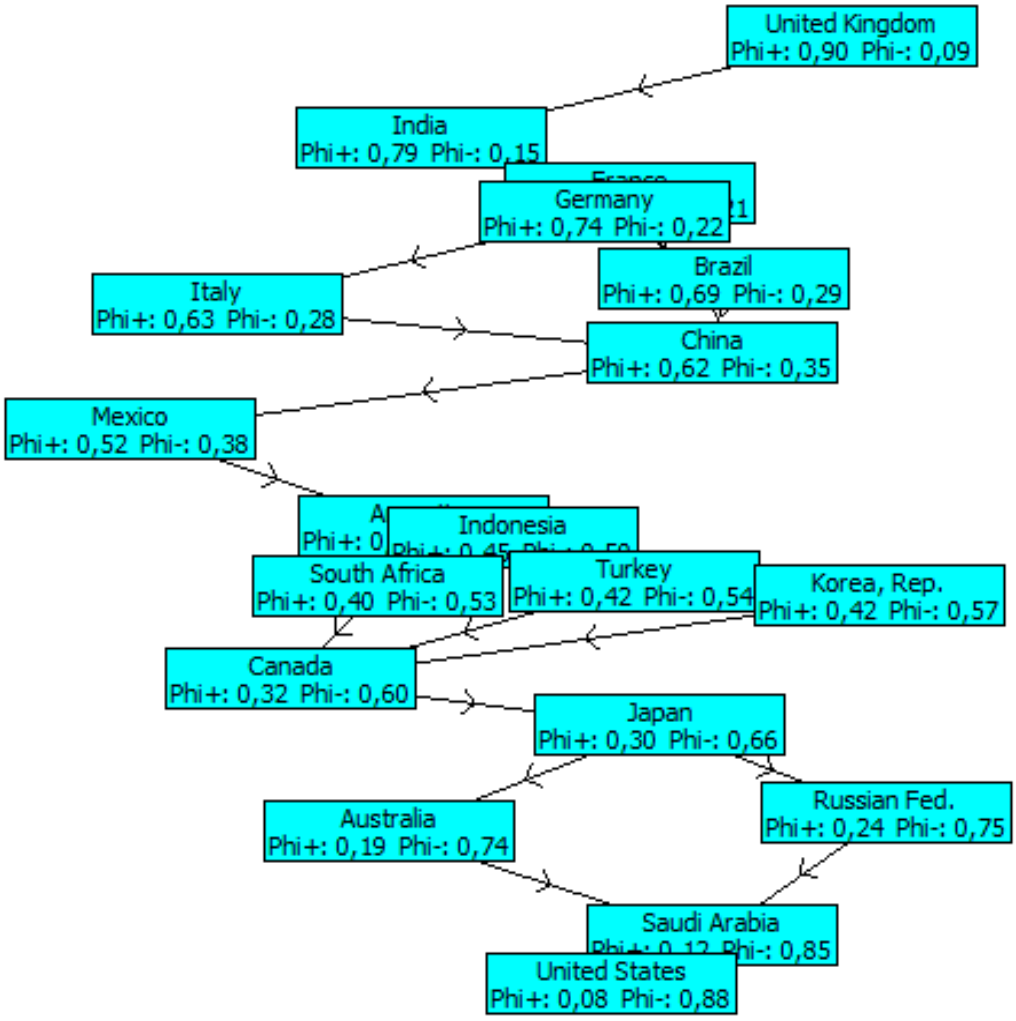
**Figure 2.** Visual PROMETHEE Program Data Entry Screen (Pre-COVID-19)




| Scenario1 | Gas Emissions | Renewable E... | Energy Use | Climate Policy |
|---|---|---|---|---|
| Unit | unit | unit | unit | unit |
| Cluster/Group | ◆ | ◆ | ◆ | ◆ |
| **Preferences** | | | | |
| Min/Max | max | max | max | max |
| Weight | 0,23 | 0,25 | 0,13 | 0,40 |
| Preference Fn. | Linear | Linear | Linear | Linear |
| Thresholds | absolute | absolute | absolute | absolute |
| - Q: Indifference | 1,00 | 1,00 | 1,00 | 1,00 |
| - P: Preference | 2,00 | 2,00 | 2,00 | 2,00 |
| - S: Gaussian | n/a | n/a | n/a | n/a |
| **Statistics** | | | | |
| **Evaluations** | | | | |
| Australia | 44,85 | 20,46 | 38,95 | 5,90 |
| Argentina | 43,95 | 17,30 | 58,70 | 68,05 |
| Brazil | 61,75 | 54,48 | 67,30 | 42,60 |
| Canada | 21,83 | 20,60 | 20,75 | 58,15 |
| China | 37,40 | 36,25 | 40,40 | 82,95 |
| France | 62,50 | 27,07 | 55,20 | 85,65 |
| Germany | 56,60 | 39,05 | 55,10 | 69,95 |
| India | 71,85 | 36,12 | 73,90 | 68,65 |
| Indonesia | 51,20 | 29,99 | 63,25 | 37,65 |
| Italy | 63,05 | 37,35 | 61,40 | 56,60 |
| Japan | 46,30 | 22,00 | 54,80 | 29,70 |
| Korea, Rep. | 14,85 | 31,67 | 14,55 | 62,30 |
| Mexico | 53,50 | 19,62 | 75,50 | 57,45 |
| Russian Fed. | 49,95 | 2,98 | 50,55 | 35,20 |
| Saudi Arabia | 5,70 | 14,93 | 13,35 | 37,30 |
| South Africa | 52,15 | 16,78 | 61,40 | 51,80 |
| Turkey | 52,95 | 47,37 | 44,90 | 4,40 |
| United States | 22,85 | 17,90 | 28,55 | 1,40 |
| United Kingdom | 76,85 | 40,60 | 66,40 | 78,45 |

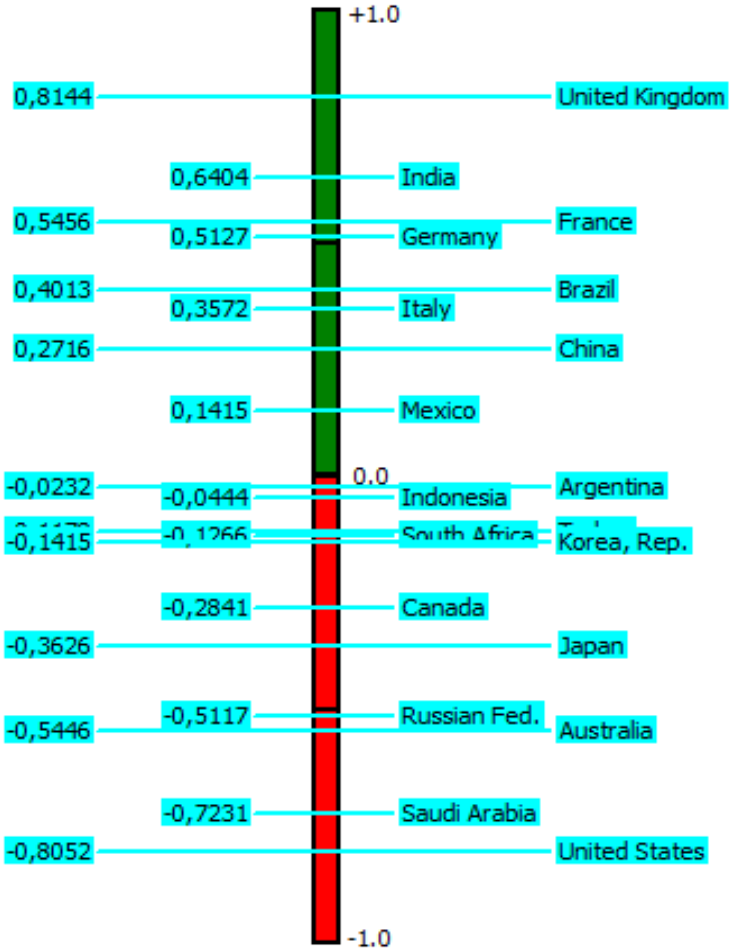
The data were evaluated according to "*PROMETHEE I*" and II using the visual *"PROMETHEE"* program and the results were given in Figure 3 and Figure 4.

**Figure 3.** Ranking Results 0btained by The PROMETHEE I (Pre-COVID-19)




Partial sequencing with "*PROMETHEE I*" is shown in Figure 3. Paired comparisons of positive and negative superiority values of decision points were made. The best-performing country according to the "*PROMETHEE I method"* in the UK. The country with the lowest performance in the USA. However, the exact ranking of some countries is unclear. Of these; as can be seen, a clear comparison of countries such as South Africa, Türkiye, and South Korea cannot be made. *"PROMETHEE II"* analysis is required for a clear comparison of alternatives. The results of the *"PROMETHEE II"* analysis are shown in Figure 4.

**Figure 4** Ranking Results Obtained by The PROMETHEE II (Pre-COVID-19)




In Figure 4, the complete ranking scores of the alternatives were obtained by PROMETHEE II analysis. Comparisons can be made clearly according to the full ranking scores. The best-performing country before COVID-19 is the UK. It is seen that the full ranking scores of Türkiye and South Africa are very close to each other. The full ranking score list is given in Figure 5 to make a clear comparison of the alternatives. The same transactions were carried out during the COVID-19 period. The decision matrix in Table 3 was used for the COVID-19 period. The analysis results of the COVID-19 period are given in Figure 5.

**Figure 5.** "PROMETHEE II", Ranking The Alternatives By A Total Preorder

***Pre-COVID-19***

PROMETHEE Flow Table

| Rank | action | Phi | Phi+ | Phi- |
|---|---|---|---|---|
| 1 | United Kingdom | 0,8144 | 0,9005 | 0,0861 |
| 2 | India | 0,6404 | 0,7880 | 0,1476 |
| 3 | France | 0,5456 | 0,7529 | 0,2074 |
| 4 | Germany | 0,5127 | 0,7351 | 0,2223 |
| 5 | Brazil | 0,4013 | 0,6863 | 0,2850 |
| 6 | Italy | 0,3572 | 0,6343 | 0,2771 |
| 7 | China | 0,2716 | 0,6208 | 0,3492 |
| 8 | Mexico | 0,1415 | 0,5213 | 0,3799 |
| 9 | Argentina | -0,0232 | 0,4563 | 0,4795 |
| 10 | Indonesia | -0,0444 | 0,4510 | 0,4954 |
| 11 | Turkey | -0,1178 | 0,4215 | 0,5393 |
| 12 | South Africa | -0,1266 | 0,4019 | 0,5286 |
| 13 | Korea, Rep. | -0,1415 | 0,4241 | 0,5656 |
| 14 | Canada | -0,2841 | 0,3181 | 0,6021 |
| 15 | Japan | -0,3626 | 0,3006 | 0,6632 |
| 16 | Russian Fed. | -0,5117 | 0,2395 | 0,7512 |
| 17 | Australia | -0,5446 | 0,1936 | 0,7381 |
| 18 | Saudi Arabia | -0,7231 | 0,1235 | 0,8466 |
| 19 | United States | -0,8052 | 0,0764 | 0,8816 |

***COVID-19 Period***

PROMETHEE Flow Table

| Rank | action | Phi | Phi+ | Phi- |
|---|---|---|---|---|
| 1 | United Kingdom | 0,7761 | 0,8058 | 0,0296 |
| 2 | India | 0,6955 | 0,7549 | 0,0594 |
| 3 | Germany | 0,5255 | 0,6859 | 0,1604 |
| 4 | France | 0,4508 | 0,6382 | 0,1873 |
| 5 | China | 0,4085 | 0,6342 | 0,2257 |
| 6 | Indonesia | 0,3364 | 0,5550 | 0,2186 |
| 7 | Italy | 0,2911 | 0,5599 | 0,2688 |
| 8 | South Africa | 0,0910 | 0,4127 | 0,3217 |
| 9 | Brazil | -0,0057 | 0,4407 | 0,4464 |
| 10 | Mexico | -0,0751 | 0,3760 | 0,4511 |
| 11 | Argentina | -0,1541 | 0,2986 | 0,4527 |
| 12 | Japan | -0,1559 | 0,3102 | 0,4662 |
| 13 | Turkey | -0,2000 | 0,3277 | 0,5277 |
| 14 | Korea, Rep. | -0,2044 | 0,3077 | 0,5121 |
| 15 | Canada | -0,3322 | 0,2557 | 0,5879 |
| 16 | Saudi Arabia | -0,5167 | 0,1280 | 0,6447 |
| 17 | United States | -0,5238 | 0,1378 | 0,6615 |
| 18 | Russian Fed. | -0,6722 | 0,1058 | 0,7781 |
| 19 | Australia | -0,7348 | 0,0838 | 0,8186 |

The full ranking is obtained by taking the difference of the negative superiority values from the positive superiorities of the alternatives and as shown in Figure 5.

Looking at the results, the UK and India, which were in the top ranks in the pre-Covid-19 period, continued their performance in the field of climate change during the pandemic period. Brazil, on the other hand, dropped its performance from the 5th to 9th place during the pandemic period. Likewise, Mexico, Argentina, Russia, Australia, and Türkiye experienced decreases in their climate change performance during the pandemic period.

Indonesia and South Africa are among the countries that performed well in the pandemic. They moved up from the 10th rank to 6th rank, from the 12th rank to 8th rank, respectively. Likewise, China, Japan, Saudi Arabia, and the USA are countries that performed well compared to the pre-pandemic period.

## DISCUSSION AND CONCLUSION

As global temperatures increase, the rise in sea level brings events such as floods, droughts, and fires. These natural events have a long-term effect on every living species. Several solutions are produced by countries to reduce the bad effects of the said climate change. In this context, potential solutions are sought by producing policies, technologies, and redesigned market and financial instruments.

Therefore, this study aims are to determine the impact of the COVID-19 pandemic on climate change performances. The developments in this context have been examined within the scope of the G-20 countries. Considering the results of the analysis, the best-performing country before and during the pandemic was determined as the UK. This finding is in line with the fact that the UK is one of the leading countries in the category of exemplary leadership and financial policies, according to the 2021 "*Green Central Banking Scorecard produced by Positive Money and Green Central Banking.*"

It is seen that the financial policies of the United Kingdom, especially within the scope of green central banking, have come a long way with a medium effect. According to the "*Climate Action Tracker (CAT)"* reports, the ongoing COVID-19 pandemic has had a serious impact on the UK economy, and the government "*rebuilding greener"* stated that she used only a small part of the recovery funds allocated with her commitment. As of October 2021, only 20% of the EU's latest 2021-2027 budget and associated economic recovery funds are allocated to low carbon green measures. However, the UK has spent more in absolute terms than major European economies such as the UK, Germany, and France, according to the November 16, 2021 report". These developments on the United Kingdom's climate change action support the results of the analysis of the study.

According to the results of the analysis, Brazil's performance during the pandemic period was negative. This result is the result of the Reuters report (2020), "*Although Brazil has a high impact on monetary policy among the G-20 countries in the 2021 green central banking scorecard, deforestation in the Amazon region of Brazil, which has a significant impact on climate change, has negatively affected this situation. Deforestation in Brazil reached its highest level in 11 years in 2019 and increased 25% more in the first half of 2020. According to the results of the analysis of the study, Brazil's plans to reduce planetary warming emissions and better adapt to climate effects will not reach the targets, which has also exhibited a negative performance during the pandemic period*" parallels the statement.

According to the results of the analysis, the USA, which was in the last place in the pre-pandemic performance ranking, showed a positive performance by rising to 17th place during the pandemic period. This result, which was found by the analysis made, is stated in the November 2021 CAT report, "*The USA has made progress in its climate policies. The US emissions reduction target and climate financing provided the UNFCCC with an improved local target to offset its fair share. Overall, it has made some progress, albeit under-rated*" coincides with the statement.

Australia was the worst-performing country during the pandemic period. This result, which is included in the 2021 CAT report, "*was assessed as critically insufficient due to low climate finance contributions and failure to meet its commitments*". Considering that this situation will affect the climate change performance of Australia at the general level, it is associated with the results of the analysis.

Türkiye, on the other hand, was among the countries whose climate and financial performance were adversely affected during the pandemic period. This result confirms the statement in the 2020 CAT report that "*Türkiye has made little progress on the implementation of climate action, apart from the 2020 Energy Efficiency Action Plan and renewable energy tenders".* However, although Turkey performed poorly during the pandemic period, contrary to the study results, according to the report of the "Energy Efficiency 2030 Strategy and II. National Energy Efficiency Action Plan"; It was noted that the targets of the first National Energy Efficiency Action Plan were achieved as planned in the years covering the 2017-2023 period. Accordingly, it was stated that approximately 70 million tons of emission reduction was achieved. For all these, 45 thousand new green jobs were created. It was emphasized that it is one of the two countries that improved energy intensity of the most in the world for two consecutive years in 2021 and 2022.

The results obtained in the study generally coincide with the results of the climate action performance analysis of the countries. The fact that the "*Climate Policy"* criterion has the most important criterion weight before and during the pandemic also supports the results obtained. Based on this result, it can be said that countries should show more effort in their climate actions and policies. It is thought that the correct direction of the financial funds used in climate change policy plans will contribute significantly to the realization of the targets.

This study, it was aimed to create awareness by emphasizing climate change, which is a big problem today. At the same time, it has been tried to get an idea about the level of activities of the G-20 countries in terms of climate change studies and its financial consequences, and how they carry out climate action during crisis periods such as pandemics. With the MCDM methods used in the study, the climate performance ranking of the G-20 countries was provided. In this context, it is thought that the integrated use of the MEREC-based PROMETHEE method will contribute to the literature. This study, which provides researchers with an idea about climate change and the financial performance of the G-20 countries, is expected to benefit future studies.

**AUTHOR DECLARATIONS**

The study does not necessitate Ethics Committee permission.

The authors contributed equally to the work.

The study has been crafted in adherence to the principles of research and publication ethics.

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