Düzce University
Journal of Science & Technology

Research Article

Analysis of Economic and Epidemic Performances of Countries During the Covid-19 Pandemic Period

Yusuf ŞAHİN [a,*], Merve KILINÇ YILMAZ [b]

[a] *Department of Business Administration, Faculty of Economics and Administrative Sciences, Burdur Mehmet Akif Ersoy University, Burdur, TURKEY*
[b] *Department of Business Administration, Institute of Social Sciences, Burdur Mehmet Akif Ersoy University, Burdur, TURKEY*
* *Corresponding author's e-mail address: ysahin@mehmetakif.edu.tr*
DOI: 10.29130/dubited.934715

ABSTRACT

This study aims to analyze the performance of countries in the COVID-19 period. The main motivation of the study is to make a more realistic assessment by taking into account the epidemic information and health system-related features, as well as government precaution (Stringency Index) and economic criteria. In this way, the characteristics of the countries that stand out in the fight against the pandemic were tried to be determined. Within the scope of the study, the CRITIC method, which is widely used and stands out as an objective method, was preferred for weighting the criteria. Country performances were analyzed separately using weighted and unweighted criteria. The Grey Relational Analysis (GRA) method, together with weighted and unweighted criteria, was used to determine country rankings. When the results are examined, it has been observed that the level of economic prosperity and the measures taken against the pandemic has brought countries directly to an advantageous point. Countries with a relatively low level of economic prosperity compared to other countries, unfortunately, ranked lower in the ranking. On the other hand, countries with elderly populations were able to find a place in the lower ranks due to high mortality rates despite their extensive economic opportunities. Although the weighting of the criteria affects the country rankings, there has been no change in the countries in the top two.

Keywords: *COVID-19 pandemic, CRITIC method, Grey relational analysis.*

Ülkelerin Covid-19 Pandemisi Dönemindeki Ekonomik ve Epidemik Performanslarının Analizi

ÖZ

Bu çalışma, ülkelerin COVID-19 dönemindeki performansını analiz etmeyi amaçlamaktadır. Çalışmanın temel motivasyonu, salgın bilgileri ve sağlık sisteminin özelliklerinin yanı sıra hükümet tedbiri (Kısıtlama İndeksi) ve ekonomik kriterleri de dikkate alarak daha gerçekçi bir değerlendirme yapmaktır. Böylelikle pandemiyle mücadelede öne çıkan ülkelerin özellikleri analiz edilmeye çalışılmıştır. Çalışma kapsamında kriterlerin ağırlıklandırılmasında yaygın olarak kullanılan ve nesnel bir yöntem olarak öne çıkan CRITIC yöntemi tercih edilmiştir. Ülke performansları ise ağırlıklı ve ağırlıksız kriterler kullanılarak ayrı ayrı analiz edilmiştir. Ülke sıralamalarını belirlemek için ağırlıklı ve ağırlıksız kriterlerle birlikte Gri İlişkisel Analiz (GİA) yöntemi kullanılmıştır. Sonuçlar incelendiğinde, ekonomik refah düzeyinin ve pandemiye karşı alınan önlemlerin ülkeleri doğrudan avantajlı bir noktaya getirdiği görülmüştür. Diğer ülkelere kıyasla nispeten düşük bir ekonomik refah seviyesine sahip ülkeler, maalesef sıralamada daha alt sıralarda yer aldı. Öte yandan yaşlı nüfusa sahip ülkeler, geniş ekonomik fırsatlarına rağmen yüksek ölüm oranları nedeniyle alt sıralarda yer bulabildiler. Kriterlerin ağırlıklandırılması ülke sıralamalarını etkilemekle birlikte ilk ikide yer alan ülkelerde herhangi bir değişiklik olmamıştır.

Anahtar kelimeler: *COVID-19 pandemisi, CRITIC yöntemi, Gri ilişkisel analiz.*

Received: 08/05/2021, Revised: 20/10/2021, Accepted: 25/10/2021

I. INTRODUCTION

Many epidemics caused by viruses have afflicted the world since the early twentieth century. Despite the Great Influenza Pandemic (1918-1919), there is currently no adequate prevention and clinical care a century later. The social, sociological, and economic consequences of the world's instability and depression are being felt profoundly all over the world [1]. The COVID-19 virus, which first emerged in the People of the Republic of China and then spread rapidly to other countries, affected millions of people worldwide and increased its severity day by day [2]. COVID-19 brought with it global economic shockwaves affecting stock markets, consumer confidence, and global supply chains [3]. Since the effect of the virus is continuing, the damage it causes to the world is not fully known. However, scientists examine this issue from different viewpoints and the literature is expanding rapidly in this context.

The different economic and socio-demographic levels of the countries prevent a homogeneous process of progress or stopping the epidemic. While economically and socio-demographically strong countries determine their precautions and policies against the epidemic with firm steps, countries with relatively weaker ones implement their precautions and policies to save more days. This situation is particularly effective in vaccination studies. On the map in Figure 1, the number of vaccines per 100,000 people in different countries is shown.

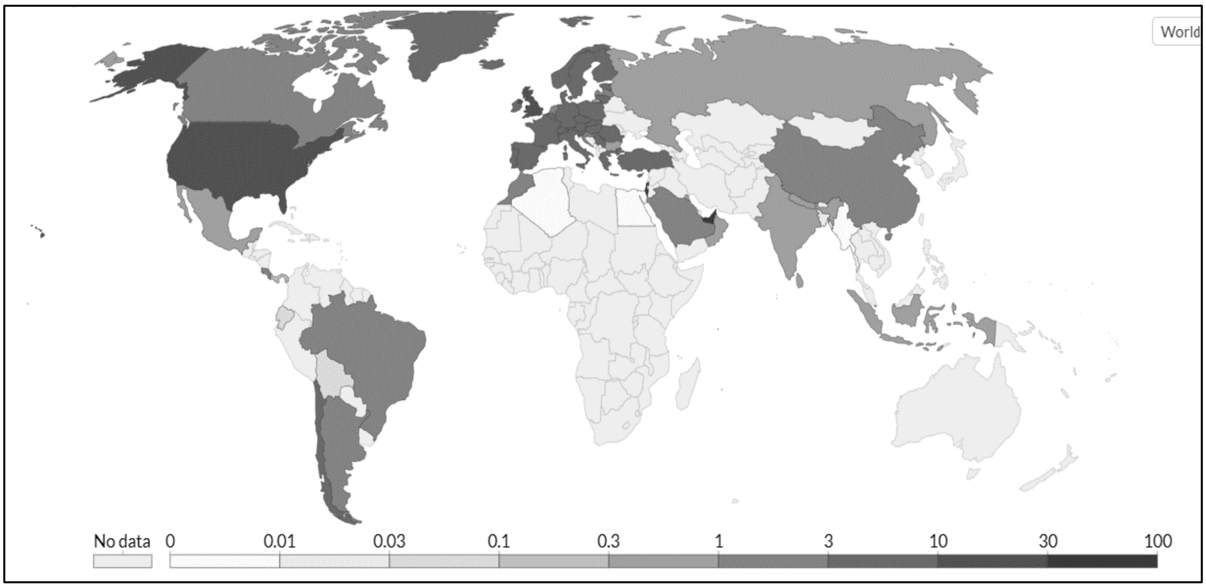

Figure 1. *The number of vaccines per 100,000 people in countries on 7 February 2021 [4]*

In the map in Figure 1, the light color scale refers to countries where vaccination information is not shared or has a minimum level of vaccine, while the dark color scale corresponds to countries where the number of vaccines per 100,000 people is relatively higher. When the map is examined, it is seen that there is a significant positive difference in regions that differ economically from other countries of the world such as North and South America, Europe, China, Russia, India, Saudi Arabia, Israel, and the United Arab Emirates. This asymmetrical situation is also present for other factors.

Numerous social and economic criteria have been attributed as potential determinants of the variation observed in coronavirus outcomes during the first wave of the pandemic. Some examples are the aging population (Gardner et al., 2020), an underdeveloped healthcare system [5], and the role of the natural environment [6], [7]. The difference in socio-economic factors also affects the reaction of countries against the COVID-19 pandemic with a high correlation. Even maintaining hygiene conditions is still a major problem for many countries. Unfortunately, the population of people who cannot reach enough water even in their daily lives is too high to underestimate. When African countries have not yet fully met their water needs and Scandinavian countries with high welfare levels, it is obvious that they will not be able to achieve the same success in the spread and control of COVID-19. Undoubtedly, the results of the process that triggers a large number of needs, from masks to hospital equipment, drug and vaccine supply to citizen-government support, are not the same in every country.

In this study, the performance of 18 countries in the COVID-19 process was analyzed by considering different factors. Finally, it was investigated whether the asymmetry, which exists in various conditions, affects the pandemic process. This paper is structured as follows. Section 1. A examines the pandemic process and its effect on countries. Section 2 reviews related literature. Section 3 includes the data set and methodology. Section 4 gives out the application and findings. Finally, section 5 concludes this paper.

A. THE IMPACT OF THE EPIDEMIC PERIOD

Starting from Wuhan city of China, it has brought different social and economic consequences according to the outbreaks experienced until today. Epidemic as of April 2021, the total number of cases exceeded 130 million worldwide, while approximately 2.84 million people died [8]. Due to its high spreading rate, it has caused life in the world to be almost paralyzed. In addition to the health crisis brought on by COVID-19, many psychological consequences of people living under long quarantine conditions have begun to be observed. Figure 2 shows the change in the number of cases approved for different countries since 2019.

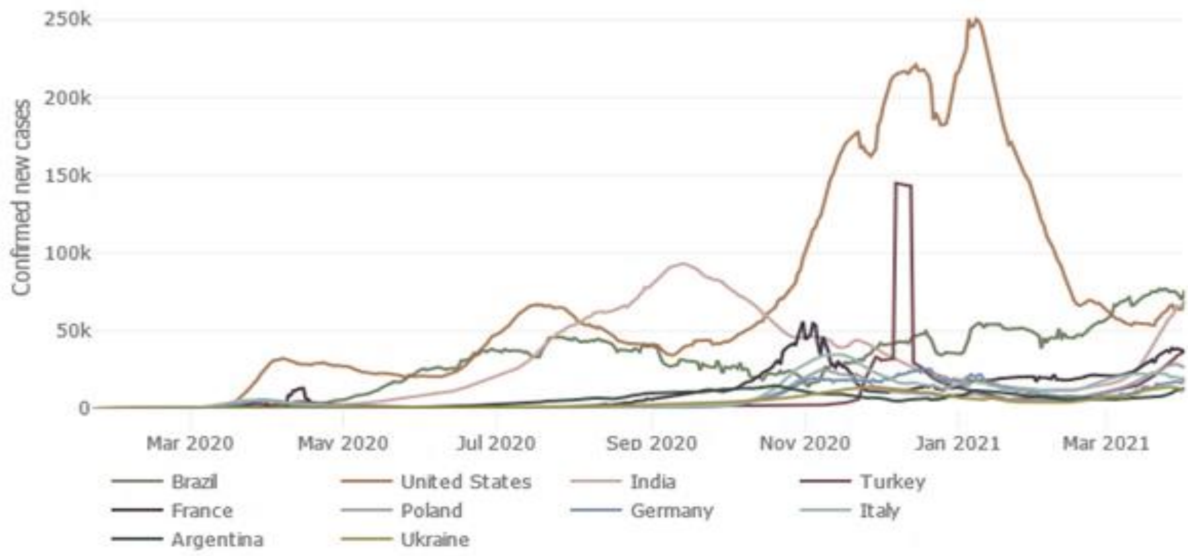

Figure 2. *Change in the number of new confirmed cases (March 2020-April 2021) [8]*

The COVID-19 pandemic includes significant differences from the major crises that occur on a global basis. Many countries have faced financial crises as well as health crises, and as a result, a major economic collapse has been experienced. For the first time since the Great Depression, both developed and emerging economies are in a state of recession. In particular, globally synchronized shutdowns and financial adversities have exposed economies to unprecedented shocks. The global spread of the virus has locked health systems and caused widespread social and economic deterioration [1]. Other consequences that make COVID-19 different from the crises experienced are that interest rates have fallen to the lowest levels in history, the world has become much more global than in previous periods, the supply chains are greatly affected and the supply and demand levels are affected accordingly [9]. Many companies have had to reduce or completely stop production due to the difficulties experienced in their supply chains.

The decrease in daily life and human activity has created a domino effect on the world. Tourism has come to a standstill, the scale of production has decreased on a global basis and significantly, and education has started to be carried out by distance education method in many countries. On the other hand, the epidemic affecting the population over 65 years of age not only damaged the underdeveloped and developing countries but also caused many losses in the developed countries with the elderly population and caused the health systems to become desperate. Although the fact that COVID-19 is continuing at full speed is of course pregnant with new problems every day, the negative consequences of the crisis have already dragged the world into a great recession and economic recession. Figure 3 shows the change in the GDP figures of major economies in 2019 and 2020.

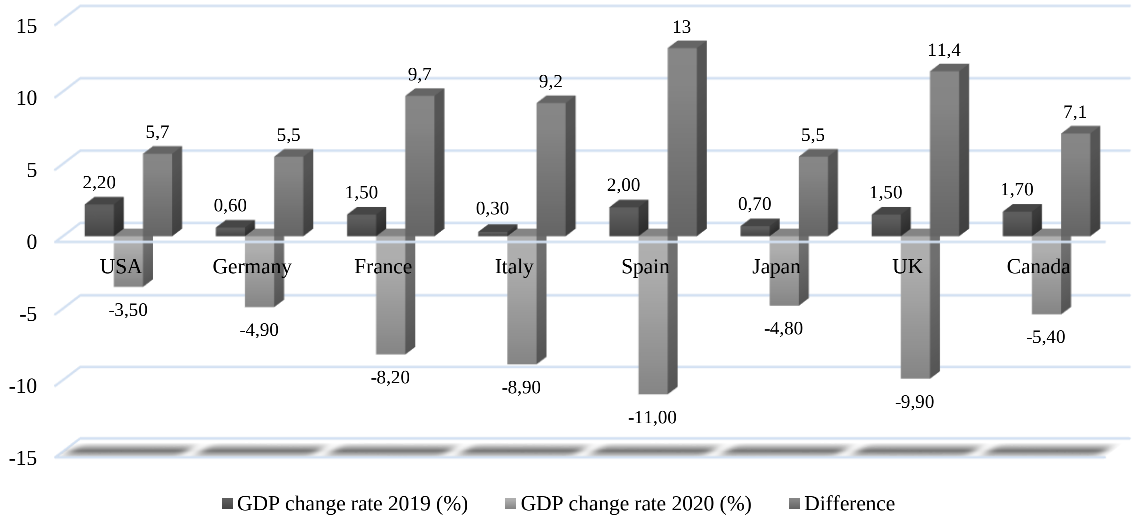

Figure 3. *GDP changes rates of advanced economies in 2019 and 2020 [10, 11]*

When the GDP change rates of developed economies are analyzed, it is seen that Spain experienced the biggest change. The United Kingdom and France follow Spain. The underlying reasons for this change are undoubtedly significant regressions in various sectors. Figure 4 shows the change in stock returns of major sectors in 2020. As can be seen from the figure, it is seen that the returns of stocks belonging to different sectors were again adversely affected by the COVID-19 crisis.

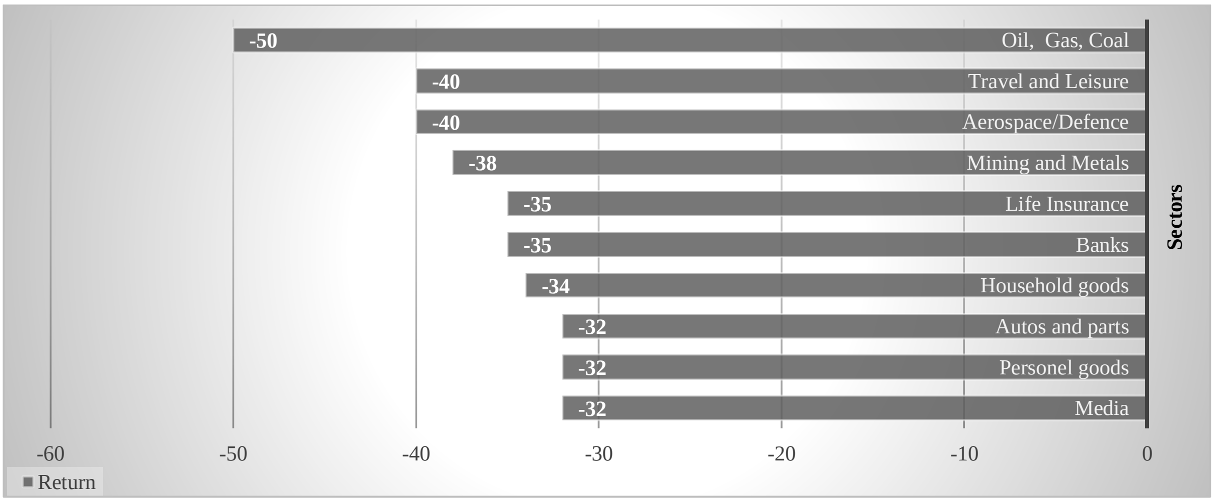

Figure 4. *The change of stock returns of major sectors in 2020 [9]*

It is seen that the most serious decrease is in the commodity sector, as the decrease in mobility and production causes a significant decrease in the demand for oil, gas, and coal. This is followed by the tourism, defense industry, mining, and metal industry. Contractions in the sectors caused companies to go bankrupt or to cease their activities. Companies that did not go bankrupt or cease their activities directed their staff to work from home and reduced their human resources. On the other hand, companies that do not shrink try to protect their income and expenditure balance by directing their personnel to unpaid leave. The year 2020 has been a year in which poverty and unemployment took off, people's living standards deteriorated and they lost their financial livelihoods. When the unemployment data of The World Bank is examined, it is seen that the unemployment rate, which was 5.37% in 2019, increased to 6.47% in 2020. This rate is the highest level reached since the '90s. Unemployment rates between 2009 and 2020 around the world are shown in Figure 5.

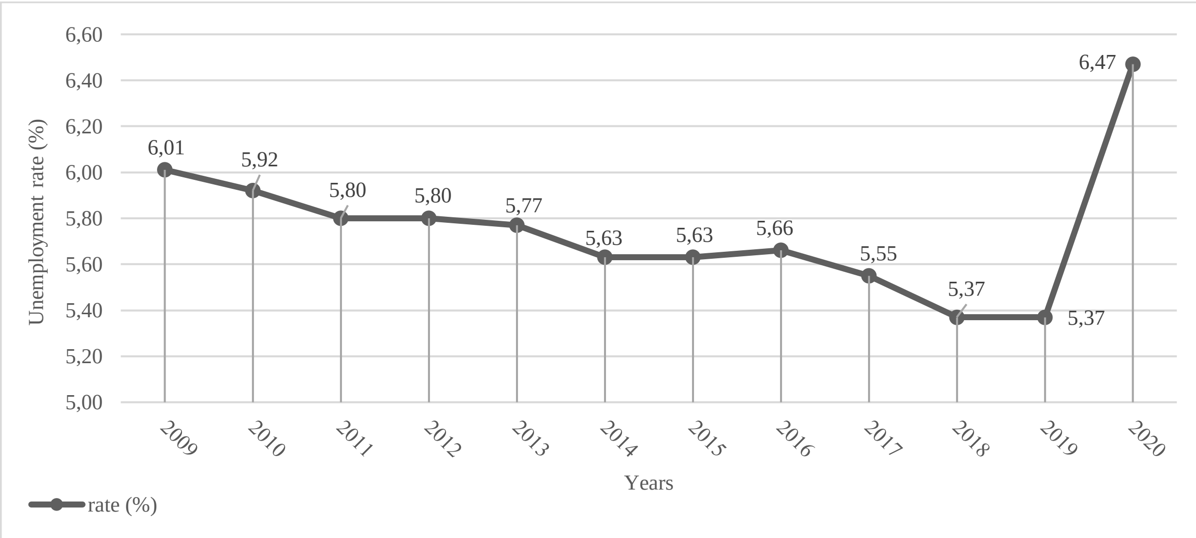

Figure 5. *World Unemployment Rate between 2009-2020 [12]*

With the incentive packages prepared by countries to avoid the economic shocks and deep recession that have occurred due to the COVID-19 epidemic, economic stability and socio-economic gains are tried to be preserved. It is seen that the measures against the epidemic are shaped within 5 categories including economic and social, fiscal policy and financing, monetary policy and liquidity, support to strengthen the health system, and social mobility restrictions. To minimize the indirect (and possibly more permanent) economic impacts of the COVID-19 crisis, it appears that a fast and well-targeted policy response is commensurate with the magnitude of the challenge. At this point, it is seen that governments apply measures and incentives to protect financial stability with direct income support, fiscal policy, and financial support to businesses and individuals through economic and social support without increasing their financial liabilities [13].

However, as mentioned above, not every country starts with the same opportunities and advantages and does not apply the same policies. At this point, profound management and performance differences arise. Naturally, countries with elderly populations start the fight against COVID-19 at a disadvantage. Countries with developed economies can turn this into an advantage within the scope of the struggle. In the literature, countries or regions have been compared according to different perspectives and new ones are being made rapidly.

II. RELATED LITERATURE

In the literature, after the COVID-19 epidemic, countries have been compared in terms of many factors including epidemic, sociological, socio-demographic, economic, psychological, and political. In some of these studies, the spreading rate of the virus and the relationships between various indicators are analyzed, while in others, countries are divided into groups based on their performance.

Studies in which countries are grouped are relatively few in the literature. Bilinski and Emanuel [14] grouped 19 countries as countries with low, medium, and high mortality rates, and analyzed the reasons for the difference. This study shows that the number of young population and central measures taken against the pandemic play an important role in the number of deaths. Peker et al. [15] compared mortality rates across continents, unlike the studies of Bilinski and Manuel [14]. When the reasons for the differences in rates are examined, it is determined that factors such as the population over 65 years of age, the smoking rate among the female population, and the life expectancy are effective. Tekin [16] evaluated 31 countries from the perspective of health and financial indicators. In this study, where hierarchical cluster analysis was used, countries were grouped with a triple, quartet, quintet, and seventh cluster structures and compared with each other.

Aydın and Yurdakul [2] conducted a detailed analysis of 142 countries using machine learning algorithms, data envelopment analysis-based algorithms, and cluster analysis. First, they clustered countries and then reached the performance coefficients of each cluster with data envelopment analysis. Jain and Singh [17] examined 67 countries in total to compare the number of deaths and cases across continents. As a result of the study, the countries with the best and worst performance were determined for each continent. Sannigrahi et al. [18] ranked 31 European countries by case and mortality rates, which were evaluated according to epidemic data. The results obtained show that there is a statistically significant relationship between the COVID-19 data and the variables of population, poverty, and income. Cao et al. [19] expanded the study conducted by Sannigrahi [18] and ranked countries according to epidemic data, taking into account 209 countries and 34 different variables worldwide.

Middelburg and Rosendaal [20] examined the number of deaths and cases in China, Germany, Italy, the Netherlands, Spain, Sweden, South Korea, and the USA. They especially focused on the differences in epidemic data in Italy, China, and South Korea. Dağcıoğlu and Keskin [21] compared the pandemic data of different countries (EU countries, Turkey, and The United States). With the correlation analysis, it was tried to determine which parameters the course of the disease was related to. According to the result obtained from epidemic data and socio-economic data, the mortality rates of countries that allocate more budget to health are lower than in other countries. Selamzade and Özdemir [22] analyzed the effectiveness of OECD countries against COVID-19 using Data Envelopment Analysis (DEA). According to the findings, it was found that the highest score belongs to Slovakia and Iceland, while the lowest score belongs to Italy and Spain. Koç and Yardımcıoğlu [13] compared Turkey and EU countries in terms of fiscal stimulus and measures. A qualitative comparison is made, in particular, and incentives to support the measures Turkey's health system has reached the conclusion that successful process management compared to countries within the European Union on the issue.

When the above studies are examined, a study in which the economic, healthcare system, and government precautions are considered together with COVID-19 data is not included in the literature. Considering that the epidemic conditions are related to all the issues mentioned here, such an assessment will provide a more accurate comparison. The main contribution of this study is the inclusion of data from many areas into the evaluation with equal and different weights. At this point, The CRiteria Importance Through Intercriteria Correlation (CRITIC) method was used for weighting the data. The GRA method, one of the components of the grey system theory, was used for ranking the country's performances.

III. METHODOLOGY AND DATA SET

Multicriteria decision-making represents both an approach and encompasses techniques or methods designed to assist people who encounter problems that may be characterized by multiple, non-uniform, and conflicting criteria, in making choices that are appropriate to their value judgments. In this study, the CRITIC method, one of the MCDM methods, was used to find the weights of the criteria used in the problem, while the GRA method was used to determine the performance ranks of the alternatives. The following sections provide information about these methods.

A. CRITIC METHOD

The CRITIC (CRiteria Importance Through Intercriteria Correlation) method proposed by Diakoulaki et al. [23] aims to determine the relative importance of objective weights in MCDM problems. The method, which is based on an analytical examination of the evaluation matrix to extract all the information included in the evaluation criteria, includes both the contrast density and the conflict in the structure of the decision problem [23]. The CRITIC method consists of three steps [24]:

Step 1: The data are normalized using Equation (1) for utility criteria and Equation (2) for cost criteria.

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \qquad i = 1, \dots, m; j = 1, \dots, n \tag{1}$$

$$r_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \qquad i = 1, \dots, m; j = 1, \dots, n \tag{2}$$

Step 2: With Equation (3), the correlation commonly used to measure the dependence between two variables is determined.

$$p_{jk} = \frac{\sum_{i=1}^{m}(r_{ij}-\bar{r}_j)(r_{ik}-\bar{r}_k)}{\sqrt{\sum_{i=1}^{m}(r_{ij}-\bar{r}_j)^2 \sum_{i=1}^{m}(r_{ik}-\bar{r}_k)^2}} \tag{3}$$

Step 3: Weights are calculated using Equation (4) and Equation (5).

$$W_j = {C_j}/{\sum_{k=1}^{n} c_k} \quad j = 1, \dots, n \tag{4}$$

$$c_j = \sigma_j \sum_{k=1}^{n}(1 - \rho_{jk}) \quad j = 1, \dots, n \tag{5}$$

B. GREY RELATIONAL ANALYSIS

The Grey System Theory (GST), proposed by Professor Deng [25], is an approach focused on the solution of problems with a small sample and incomplete information [26]. GST is a multidisciplinary theory that deals with incomplete and inadequate information structures [27]. The Grey Relational Analysis (GRA) method is one of the six headings of the GST proposed by Deng [25] [28-30]. This method, which is used to eliminate and analyze the uncertain relationships between criteria and options, has applications such as damage assessment [31], determination of the critical path through a network plan [32], a causal decision-making model [33], supplier selection [34-37], system security assessment [38], determining the importance of smartphone technical features [26], and evaluating health service quality factors [39].

GRA is a method used to determine the degree of relationship between each factor in a system and the compared factor (reference set) series. Each factor is defined as an array (row or column). The degree of influence between factors is defined as a “grey relational degree” [40]. The grey relational degrees of the determining factors are obtained by comparing the geometric trends shown by the factors [41]. The steps of the method are presented below [39].

Step 1. Creating the Decision Matrix: For the decision problem consisting of “*m”* alternatives and “*n*” criteria, a decision matrix of size *m*x*n* is created as shown in Equation (6). The $x_i(k)$ expression in this matrix corresponds to the value of alternative *i* for the criterion *j*.

$$X_{m*n} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \tag{6}$$

Step 2. Creating the Reference Series: A reference series is created by taking the smallest value of the alternatives for minimization-oriented criteria and the largest value for maximization-oriented alternatives.

Step 3. Building the Comparison Series: To normalize the data, Equation (7), Equation (8), or Equation (9) are used, respectively, according to the benefit, cost, and optimality of the criteria.

$$x_i^*(k) = \frac{x_i(k) - minx_i(k)}{maxx_i(k) - minx_i} \tag{7}$$

$$x_i^*(k) = \frac{maxx_i(k) - x_i(k)}{maxx_i(k) - min_i(k)} \tag{8}$$

$$x_i^*(k) = \frac{x_i(k) - x_{ob}(k)}{maxx_i(k) - min_i(k} \tag{9}$$

Here:

$x_i(k)$: The value of alternative *i* for criteria *k*
$x_i^*(k)$: The normalized value of alternative *i* for criteria *k*
$minx_i(k)$: The smallest value for criteria *k*
$maxx_i(k)$: The maximum value for criteria *k*
$x_{ob}(k)$: Reference series (ideal sequence) value for criteria *k*

Step 4. Creating the Absolute Value Table: Absolute differences ($\Delta x_i(k)$) are calculated with the help of Equation (10), where $x_0^*(k)$ is the normalized value of the reference value for the criteria *k* and the $x_i^*(k)$ is the normalized value of the alternative for the criteria *k*.

$$\Delta x_i(k) = |x_0^*(k) - x_i^*(k)| \tag{10}$$

Step 5. Calculation of Grey Relational Coefficient Matrix for Different Data Series: Grey relational coefficients are calculated with the help of Equation (11), where Δ_{min} and Δ_{max} are the smallest and largest value in the absolute difference matrix, and $\Delta_i(k)$ is the absolute difference between the reference series value and the value of the alternative *k*. The discriminant coefficient (δ) is used to eliminate the possibility of being the most extreme value in the data series and is generally taken as 0.5 [42].

$$\gamma_{01}(k) = (\Delta_{min} + \delta\Delta_{max})/(\Delta_i(k) + \delta\Delta_{max}) \tag{11}$$

Step 6. Calculate the grey relationship degree for each different data set to build a relationship matrix: Grey relational degrees (γ_i) are calculated by dividing the sum of the grey relational coefficients obtained with Equation (11) by the number of criteria (*n*) [43]. If there are different weights for the data, Equation (13) should be used to calculate the grey relational degrees.

$$\gamma_i = \frac{1}{n}\sum_{j=1}^{n} \gamma_{0i}(j) \tag{12}$$

$$\gamma_i = \sum_{k=1}^{n}[w_k * \gamma_{0i}(j)] \tag{13}$$

C. DATA SET

During the COVID-19 pandemic, countries have been compared from different perspectives. The data groups used also differ according to these compared perspectives. While some of the studies are based entirely on epidemic data, some of them use a data set consisting of a combination of socio-demographic, socio-economic, and epidemic data. The data used in our study and the data used in different studies in the literature are summarized in Table 1 and Table 2, respectively.

Table 1. *Criteria used in the study and related information*

Main Criteria (MC)	**Sub-criteria**	**Abbreviation**	**Year**	**Data source**
COVID-19 (MC_1)	Deaths (per hundred thousand)	K_1	2021	[8]
	Number of Tests / Population (per million)	K_2	2021	
	Number of Cases (per hundred thousand)	K_3	2021	
	Vaccinated population (%)	K_4	2021	
Economic (MC_2)	GDP Per Capita ($)	K_5	2020	[44]
	Health Spending / GDP	K_6	2020	[45]
	Unemployment rate (%)	K_7	2020	[46]
	Consumer price index (%)	K_8	2020	[47]
	Poor Population Rate (%)	K_9	2020	[4]
Healthcare System (MC_3)	Number of hospital beds (per 1000 People)	K_{10}	2021	[4]
	Number of doctors (per 1000 People)	K_{11}	2021	
Government Precaution (MC_4)	Stringency Index	K_{12}	2021	[4]

Table 2. *Data groups (criteria) used by studies in the literature*

Article \ **Criteria**	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Aydın and Yurdakul [2]	√	√	√						√	√		√
Peker et al. [15]	√		√							√		
Middelburg and Rosendaal [20]		√	√									
Cao et al. [19]	√		√		√				√	√		√
Dağcıoğlu and Keskin [21]	√	√	√			√					√	
Tekin [16]	√	√	√			√		√			√	
Selamzade and Özdemir [22]	√	√	√			√				√	√	
Sannigrahi et al. [18]	√	√	√						√			

When the data sets used in the studies are examined, it is seen that the number of deaths / total population, number of tests / total population, number of cases / total population, and vaccinated population (%) are used for COVID-19. Regarding the economic situation of the countries, per capita GDP, Health expenditure/GDP, unemployment rate (%), consumer price index, and poor population ratio (%) data are used. Regarding healthcare services, the data on the number of beds (per 1000 people) and the number of doctors (per 1000 people) in hospital facilities are preferred for comparison. In addition to all these, it is observed that the data called "Stringency Index" are frequently used in studies. It is concluded that the higher the value of this index, which can take a value between 0 and 100, the stricter and more disciplined the measures are. The index score consists of the answers to 9 different questions in total. The questions consist of components such as school closures, workplaces, curfews, and travel bans.

Among the criteria above, K_5, K_6, K_7, K_8, and K_9 are the data that directly examine the economic situation of the countries. These data are published quarterly or annually in information systems. For this reason, the average data for 2020 were included in the study. Data other than the specified data groups are monitored daily during the COVID-19 process. The date these data groups are added to the data set is April 2021. Since the performance comparison of countries was aimed at in the study, the alternative set was determined after the criteria set. The list of countries evaluated within the scope of the study is shown in Table 3.

Table 3. *The list of countries*

Abbreviation	Countries	Abbreviation	Countries
A_1	Germany	A_{10}	South Kore
A_2	USA	A_{11}	India
A_3	Argentina	A_{12}	United Kingdom
A_4	Australia	A_{13}	Italy
A_5	Brazil	A_{14}	Japan
A_6	China	A_{15}	Canada
A_7	Indonesia	A_{16}	Mexico
A_8	France	A_{17}	Russia
A_9	South Africa	A_{18}	Saudi Arabia

In the study, it was aimed to rank the performance of 18 countries according to 12 criteria. Measuring the performance of 18 alternatives according to 12 criteria falls within the scope of decision making and multi-criteria decision making (MCDM) problems due to the characteristics of the problem.

IV. RESULTS AND FINDINGS

CRITIC and GRA methods were used to measure the pandemic performance of 18 countries during the COVID-19 pandemic. Criteria weights obtained from the CRITIC method were used for the weighting of data in the GRA method. The initial decision matrix is shown in Table 4.

Table 4. *Initial decision matrix*

CRITERIA	MC1					MC2				MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Goal / Alternative	min	max	min	max	max	max	min	min	min	max	max	max
A_1	94,35	497428	3,6E-02	5,60	47514	11,200	3,000	105,0	16,0	8,00	4,31	83,33
A_2	169,22	994342	9,4E-02	19,20	62917	17,100	3,900	117,0	17,8	2,77	2,60	68,06
A_3	137,82	147192	6,0E-02	1,60	11688	9,100	10,400	233,0	35,5	5,00	3,86	79,17
A_4	3,89	528573	1,3E-03	3,94	58393	9,200	5,300	120,0	12,4	3,84	5,20	81,94
A_5	162,32	133964	6,2E-02	2,50	8920	9,500	12,000	167,0	19,9	2,20	1,89	72,69
A_6	0,34	111163	7,1E-05	10,34	9532	5,200	4,400	109,0	6,0	4,34	2,00	78,24
A_7	15,44	36083	5,7E-03	1,60	3893	3,000	4,800	151,0	9,8	1,04	0,30	64,35
A_8	152,74	726202	7,8E-02	4,80	41381	11,300	8,300	110,0	13,4	5,98	3,37	63,89
A_9	100,75	143986	2,9E-02	0,50	12295	8,750	28,100	117,3	55,5	2,32	0,80	72,22
A_{10}	3,58	117273	2,2E-03	0,10	33622	7,600	4,600	115,0	17,4	12,27	2,39	63,89
A_{11}	12,11	147506	9,4E-03	0,80	2055	3,500	5,400	180,0	21,9	0,53	0,78	68,98
A_{12}	201,51	1178570	6,9E-02	8,50	42526	9,600	4,100	121,0	18,6	2,54	2,95	86,11
A_{13}	185,05	585775	6,1E-02	6,00	34388	8,800	9,800	111,0	20,3	3,18	4,02	78,70
A_{14}	7,32	550224	3,9E-03	0,30	39082	10,900	2,300	105,0	15,7	13,05	2,49	49,54
A_{15}	65,93	598766	3,0E-02	2,00	46192	10,600	5,400	117,0	12,1	2,50	2,80	75,46
A_{16}	168,51	38656	1,9E-02	1,20	9695	5,500	3,600	142,0	41,9	1,38	2,44	71,76
A_{17}	68,63	723421	3,1E-02	3,60	11394	3,700	4,400	181,0	12,9	8,05	4,09	45,83
A_{18}	23,34	370540	1,4E-02	15,49	23217	5,800	5,900	117,0	17,7	2,70	2,40	50,00

A. DETERMINATION OF WEIGHTS WITH CRITIC METHOD

The 12 criteria in the initial decision matrix are broadly classified as COVID-19, economic, healthcare system, and government precaution. In the first step of the CRITIC method, the normalization process is performed by applying the equations in Equation (1) and Equation (2) to the data presented in Table 4. Normalized versions of the data are shown in Table 5.

Table 5. *Normalized data for CRITIC Method*

ALTERNATIVES	MC1					MC2				MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
A_1	0,53	0,40	0,62	0,29	0,75	0,58	0,97	1,00	0,80	0,60	0,82	0,93
A_2	0,16	0,84	0,00	1,00	1,00	1,00	0,94	0,91	0,76	0,18	0,47	0,55
A_3	0,32	0,10	0,36	0,08	0,16	0,43	0,69	0,00	0,40	0,36	0,73	0,83
A_4	0,98	0,43	0,99	0,20	0,93	0,44	0,88	0,88	0,87	0,26	1,00	0,90
A_5	0,19	0,09	0,33	0,13	0,11	0,46	0,62	0,52	0,72	0,13	0,32	0,67
A_6	1,00	0,07	1,00	0,54	0,12	0,16	0,92	0,97	1,00	0,30	0,35	0,80
A_7	0,92	0,00	0,94	0,08	0,03	0,00	0,90	0,64	0,92	0,04	0,00	0,46
A_8	0,24	0,60	0,17	0,25	0,65	0,59	0,77	0,96	0,85	0,44	0,63	0,45
A_9	0,50	0,09	0,69	0,02	0,17	0,41	0,00	0,90	0,00	0,14	0,10	0,66
A_{10}	0,98	0,07	0,98	0,00	0,52	0,33	0,91	0,92	0,77	0,94	0,43	0,45
A_{11}	0,94	0,10	0,90	0,04	0,00	0,04	0,88	0,41	0,68	0,00	0,10	0,57
A_{12}	0,00	1,00	0,26	0,44	0,66	0,47	0,93	0,88	0,75	0,16	0,54	1,00
A_{13}	0,08	0,48	0,35	0,31	0,53	0,41	0,71	0,95	0,71	0,21	0,76	0,82
A_{14}	0,97	0,45	0,96	0,01	0,61	0,56	1,00	1,00	0,80	1,00	0,45	0,09
A_{15}	0,67	0,49	0,68	0,10	0,73	0,54	0,88	0,91	0,88	0,16	0,51	0,74
A_{16}	0,16	0,00	0,80	0,06	0,13	0,18	0,95	0,71	0,27	0,07	0,44	0,64
A_{17}	0,66	0,60	0,67	0,18	0,15	0,05	0,92	0,41	0,86	0,60	0,77	0,00
A_{18}	0,89	0,29	0,85	0,81	0,35	0,20	0,86	0,91	0,76	0,17	0,43	0,10

In the second step, the correlation value (p_{jk}), which is commonly used to measure the dependency between the variable, is determined with the help of Equation (3). The correlation relationship between the criteria is shown in Table 6.

Table 6. *Relationship coefficient matrix*

CRITERIA	MC1					MC2				MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
K_1	1,00	-0,41	0,87	-0,19	-0,16	-0,46	0,23	0,09	0,37	0,31	-0,22	-0,38
K_2	-0,41	1,00	-0,58	0,49	0,73	0,58	0,27	0,33	0,33	0,11	0,49	0,03
K_3	0,87	-0,58	1,00	-0,39	-0,33	-0,65	0,17	0,10	0,11	0,20	-0,25	-0,25
K_4	-0,19	0,49	-0,39	1,00	0,39	0,37	0,24	0,32	0,29	-0,22	0,14	-0,02
K_5	-0,16	0,73	-0,33	0,39	1,00	0,79	0,29	0,59	0,32	0,28	0,58	0,21
K_6	-0,46	0,58	-0,65	0,37	0,79	1,00	-0,05	0,37	-0,01	0,18	0,35	0,26
K_7	0,23	0,27	0,17	0,24	0,29	-0,05	1,00	0,09	0,71	0,27	0,29	-0,14
K_8	0,09	0,33	0,10	0,32	0,59	0,37	0,09	1,00	0,25	0,21	0,06	0,05
K_9	0,37	0,33	0,11	0,29	0,32	-0,01	0,71	0,25	1,00	0,24	0,23	-0,15
K_{10}	0,31	0,11	0,20	-0,22	0,28	0,18	0,27	0,21	0,24	1,00	0,34	-0,39
K_{11}	-0,22	0,49	-0,25	0,14	0,58	0,35	0,29	0,06	0,23	0,34	1,00	0,21
K_{12}	-0,38	0,03	-0,25	-0,02	0,21	0,26	-0,14	0,05	-0,15	-0,39	0,21	1,00

In the last step, the criteria weights were determined using Equation (4) and Equation (5). As shown in Table 7, the order of importance of the criteria was determined as $K_1 \succ K_3 \succ K_{12} \succ K_{10} \succ K_4 \succ K_2 \succ K_5 \succ K_{11} \succ K_8 \succ K_6 \succ K_9 \succ K_7$. The most important criteria is the number of COVID-19 deaths (K_1), while the least important criteria is the unemployment rate (K_7).

Table 7. *Calculation of criteria weights*

CRITERIA	MC1					MC2				MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
K_1	0,00	1,41	0,13	1,19	1,16	1,46	0,77	0,91	0,63	0,69	1,22	1,38
K_2	1,41	0,00	1,58	0,51	0,27	0,42	0,73	0,67	0,67	0,89	0,51	0,97
K_3	0,13	1,58	0,00	1,39	1,33	1,65	0,83	0,90	0,89	0,80	1,25	1,25
K_4	1,19	0,51	1,39	0,00	0,61	0,63	0,76	0,68	0,71	1,22	0,86	1,02
K_5	1,16	0,27	1,33	0,61	0,00	0,21	0,71	0,41	0,68	0,72	0,42	0,79
K_6	1,46	0,42	1,65	0,63	0,21	0,00	1,05	0,63	1,01	0,82	0,65	0,74
K_7	0,77	0,73	0,83	0,76	0,71	1,05	0,00	0,91	0,29	0,73	0,71	1,14
K_8	0,91	0,67	0,90	0,68	0,41	0,63	0,91	0,00	0,75	0,79	0,94	0,95
K_9	0,63	0,67	0,89	0,71	0,68	1,01	0,29	0,75	0,00	0,76	0,77	1,15
K_{10}	0,69	0,89	0,80	1,22	0,72	0,82	0,73	0,79	0,76	0,00	0,66	1,39
K_{11}	1,22	0,51	1,25	0,86	0,42	0,65	0,71	0,94	0,77	0,66	0,00	0,79
K_{12}	1,38	0,97	1,25	1,02	0,79	0,74	1,14	0,95	1,15	1,39	0,79	0,00
σ	0,37	0,30	0,32	0,28	0,32	0,25	0,23	0,27	0,25	0,29	0,27	0,29
C_j	4,01	2,58	3,83	2,70	2,35	2,30	1,98	2,34	2,05	2,75	2,34	3,38
Total (C_j)	32,60											
W_j	0,123	0,079	0,117	0,083	0,072	0,071	0,061	0,072	0,063	0,084	0,072	0,104

B. RANKING OF COUNTRIES WITH GRA

GRA is a method used to determine the degree of relationship between each factor in a system and the compared factor (reference set) series. The method consists of three basic steps: normalization, grey relational coefficient calculation, and grey relational degree calculation. After creating the decision matrix (see Table 4), the first step is to determine the reference series. The decision matrix in which the reference series is included is shown in Table 8.

Table 8. *Decision matrix and reference series for GRA*

	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Reference	**0,340**	**1178570**	**0,00**	**19,20**	**62917**	**17,10**	**2,30**	**105,00**	**6,00**	**13,05**	**5,20**	**86,11**
Countries	min	max	min	max	max	max	min	min	min	max	max	max
A_1	94,35	497428	3,6E-02	5,60	47514	11,200	3,000	105,0	16,0	8,00	4,31	83,33
A_2	169,22	994342	9,4E-02	19,20	62917	17,100	3,900	117,0	17,8	2,77	2,60	68,06
A_3	137,82	147192	6,0E-02	1,60	11688	9,100	10,400	233,0	35,5	5,00	3,86	79,17
A_4	3,89	528573	1,3E-03	3,94	58393	9,200	5,300	120,0	12,4	3,84	5,20	81,94
A_5	162,32	133964	6,2E-02	2,50	8920	9,500	12,000	167,0	19,9	2,20	1,89	72,69
A_6	0,34	111163	7,1E-05	10,34	9532	5,200	4,400	109,0	6,0	4,34	2,00	78,24
A_7	15,44	36083	5,7E-03	1,60	3893	3,000	4,800	151,0	9,8	1,04	0,30	64,35
A_8	152,74	726202	7,8E-02	4,80	41381	11,300	8,300	110,0	13,4	5,98	3,37	63,89
A_9	100,75	143986	2,9E-02	0,50	12295	8,750	28,100	117,3	55,5	2,32	0,80	72,22
A_{10}	3,58	117273	2,2E-03	0,10	33622	7,600	4,600	115,0	17,4	12,27	2,39	63,89
A_{11}	12,11	147506	9,4E-03	0,80	2055	3,500	5,400	180,0	21,9	0,53	0,78	68,98
A_{12}	201,51	1178570	6,9E-02	8,50	42526	9,600	4,100	121,0	18,6	2,54	2,95	86,11
A_{13}	185,05	585775	6,1E-02	6,00	34388	8,800	9,800	111,0	20,3	3,18	4,02	78,70
A_{14}	7,32	550224	3,9E-03	0,30	39082	10,900	2,300	105,0	15,7	13,05	2,49	49,54
A_{15}	65,93	598766	3,0E-02	2,00	46192	10,600	5,400	117,0	12,1	2,50	2,80	75,46
A_{16}	168,51	38656	1,9E-02	1,20	9695	5,500	3,600	142,0	41,9	1,38	2,44	71,76
A_{17}	68,63	723421	3,1E-02	3,60	11394	3,700	4,400	181,0	12,9	8,05	4,09	45,83
A_{18}	23,34	370540	1,4E-02	15,49	23217	5,800	5,900	117,0	17,7	2,70	2,40	50,00

After the decision matrix and reference series are created, the normalization process is performed in the decision matrix with the appropriate one from Equation (7), Equation (8), or Equation (9) according to the benefits, cost, and optimality of the criteria. Equation (8) should be used for minimization-oriented criteria (K_1, K_3, K_7, K_8, and K_9) in Table 8. The remaining criteria should be normalized with the help of Equation (7) since they are maximization-oriented. The normalized decision matrix obtained as a result of the normalization process with the help of these equations is shown in Table 9.

Table 9. *Normalized decision matrix for GRA*

CRITERIA	**MC$_1$**				**MC$_2$**					**MC$_3$**		**MC$_4$**
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Reference Series / **Countries**	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
A_1	0,53	0,40	0,62	0,29	0,75	0,58	0,97	1,00	0,80	0,60	0,82	0,93
A_2	0,16	0,84	0,00	1,00	1,00	1,00	0,94	0,91	0,76	0,18	0,47	0,55
A_3	0,32	0,10	0,36	0,08	0,16	0,43	0,69	0,00	0,40	0,36	0,73	0,83
A_4	0,98	0,43	0,99	0,20	0,93	0,44	0,88	0,88	0,87	0,26	1,00	0,90
A_5	0,19	0,09	0,34	0,13	0,11	0,46	0,62	0,52	0,72	0,13	0,32	0,67
A_6	1,00	0,07	1,00	0,54	0,12	0,16	0,92	0,97	1,00	0,30	0,35	0,80
A_7	0,92	0,00	0,94	0,08	0,03	0,00	0,90	0,64	0,92	0,04	0,00	0,46
A_8	0,24	0,60	0,17	0,25	0,65	0,59	0,77	0,96	0,85	0,44	0,63	0,45
A_9	0,50	0,09	0,69	0,02	0,17	0,41	0,00	0,90	0,00	0,14	0,10	0,66
A_{10}	0,98	0,07	0,98	0,00	0,52	0,33	0,91	0,92	0,77	0,94	0,43	0,45
A_{11}	0,94	0,10	0,90	0,04	0,00	0,04	0,88	0,41	0,68	0,00	0,10	0,57
A_{12}	0,00	1,00	0,27	0,44	0,66	0,47	0,93	0,88	0,75	0,16	0,54	1,00
A_{13}	0,08	0,48	0,35	0,31	0,53	0,41	0,71	0,95	0,71	0,21	0,76	0,82
A_{14}	0,97	0,45	0,96	0,01	0,61	0,56	1,00	1,00	0,80	1,00	0,45	0,09
A_{15}	0,67	0,49	0,68	0,10	0,73	0,54	0,88	0,91	0,88	0,16	0,51	0,74
A_{16}	0,16	0,00	0,80	0,06	0,13	0,18	0,95	0,71	0,27	0,07	0,44	0,64
A_{17}	0,66	0,60	0,67	0,18	0,15	0,05	0,92	0,41	0,86	0,60	0,77	0,00
A_{18}	0,89	0,29	0,85	0,81	0,35	0,20	0,86	0,91	0,76	0,17	0,43	0,10

After the normalization process, the absolute value table is created by using Equation (10) in the third step. The absolute value table prepared based on the data in Table 9 is shown in Table 10.

***Table 10.** Absolute value table*

CRITERIA	MC1				MC2					MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Reference Series / Countries	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
A_1	0,47	0,60	0,38	0,71	0,25	0,42	0,03	0,00	0,20	0,40	0,18	0,07
A_2	0,84	0,16	1,00	0,00	0,00	0,00	0,06	0,09	0,24	0,82	0,53	0,45
A_3	0,68	0,90	0,64	0,92	0,84	0,57	0,31	1,00	0,60	0,64	0,27	0,17
A_4	0,02	0,57	0,01	0,80	0,07	0,56	0,12	0,12	0,13	0,74	0,00	0,10
A_5	0,81	0,91	0,66	0,87	0,89	0,54	0,38	0,48	0,28	0,87	0,68	0,33
A_6	0,00	0,93	0,00	0,46	0,88	0,84	0,08	0,03	0,00	0,70	0,65	0,20
A_7	0,08	1,00	0,06	0,92	0,97	1,00	0,10	0,36	0,08	0,96	1,00	0,54
A_8	0,76	0,40	0,83	0,75	0,35	0,41	0,23	0,04	0,15	0,56	0,37	0,55
A_9	0,50	0,91	0,31	0,98	0,83	0,59	1,00	0,10	1,00	0,86	0,90	0,34
A_{10}	0,02	0,93	0,02	1,00	0,48	0,67	0,09	0,08	0,23	0,06	0,57	0,55
A_{11}	0,06	0,90	0,10	0,96	1,00	0,96	0,12	0,59	0,32	1,00	0,90	0,43
A_{12}	1,00	0,00	0,73	0,56	0,34	0,53	0,07	0,13	0,25	0,84	0,46	0,00
A_{13}	0,92	0,52	0,65	0,69	0,47	0,59	0,29	0,05	0,29	0,79	0,24	0,18
A_{14}	0,03	0,55	0,04	0,99	0,39	0,44	0,00	0,00	0,20	0,00	0,55	0,91
A_{15}	0,33	0,51	0,32	0,90	0,27	0,46	0,12	0,09	0,12	0,84	0,49	0,26
A_{16}	0,84	1,00	0,20	0,94	0,87	0,82	0,05	0,29	0,73	0,93	0,56	0,36
A_{17}	0,34	0,40	0,33	0,82	0,85	0,95	0,08	0,59	0,14	0,40	0,23	1,00
A_{18}	0,11	0,71	0,15	0,19	0,65	0,80	0,14	0,09	0,24	0,83	0,57	0,90

After calculating the absolute value table, grey relational coefficients ($\gamma_{01}(k)$) with the help of Equation (11) in the fifth step. The differential coefficient (δ) in this equation is taken as 0.5. Grey relational coefficients calculated for countries are given in Table 11.

***Table 11.** Grey relational coefficients*

	MC1				MC2					MC3		MC4
	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}
Reference Series / Countries	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
A_1	0,52	0,46	0,57	0,41	0,66	0,54	0,95	1,00	0,71	0,55	0,73	0,88
A_2	0,37	0,76	0,33	1,00	1,00	1,00	0,89	0,84	0,68	0,38	0,49	0,53
A_3	0,42	0,36	0,44	0,35	0,37	0,47	0,61	0,33	0,46	0,44	0,65	0,74
A_4	0,97	0,47	0,97	0,38	0,87	0,47	0,81	0,81	0,79	0,40	1,00	0,83
A_5	0,38	0,35	0,43	0,36	0,36	0,48	0,57	0,51	0,64	0,37	0,43	0,60
A_6	1,00	0,35	1,00	0,52	0,36	0,37	0,86	0,94	1,00	0,42	0,43	0,72
A_7	0,87	0,33	0,89	0,35	0,34	0,33	0,84	0,58	0,87	0,34	0,33	0,48
A_8	0,40	0,56	0,38	0,40	0,59	0,55	0,68	0,93	0,77	0,47	0,57	0,48
A_9	0,50	0,36	0,62	0,34	0,38	0,46	0,33	0,84	0,33	0,37	0,36	0,59
A_{10}	0,97	0,35	0,96	0,33	0,51	0,43	0,85	0,86	0,68	0,89	0,47	0,48
A_{11}	0,90	0,36	0,83	0,34	0,33	0,34	0,81	0,46	0,61	0,33	0,36	0,54
A_{12}	0,33	1,00	0,41	0,47	0,60	0,48	0,88	0,80	0,66	0,37	0,52	1,00
A_{13}	0,35	0,49	0,44	0,42	0,52	0,46	0,63	0,91	0,63	0,39	0,67	0,73
A_{14}	0,94	0,48	0,92	0,34	0,56	0,53	1,00	1,00	0,72	1,00	0,47	0,36
A_{15}	0,61	0,50	0,61	0,36	0,65	0,52	0,81	0,84	0,80	0,37	0,51	0,65
A_{16}	0,37	0,33	0,71	0,35	0,36	0,38	0,91	0,63	0,41	0,35	0,47	0,58
A_{17}	0,60	0,56	0,60	0,38	0,37	0,34	0,86	0,46	0,78	0,56	0,69	0,33
A_{18}	0,81	0,41	0,77	0,72	0,43	0,38	0,78	0,84	0,68	0,38	0,47	0,36

In the last step, the grey relational degrees (γ_i) are calculated by dividing the sum of the grey relational coefficients by the number of criteria (n) (Equation 12). At this point, if there are different weights for the data points, Equation (13) should be used to calculate the grey relational degree. In this study, Equation (12) and Equation (13) are used because the criteria are used with different weights. The grey relational coefficients and the obtained grey relational degrees (weighted and unweighted) are shown in Table 12.

Table 12. Calculation of grey relational degrees

Countries	Unweighted		Weighted	
	GRD	Rank	GRD	Rank
A_1	0.6656	4	0.6511	5
A_2	0.6886	3	0.6487	6
A_3	0.4702	16	0.4711	16
A_4	0.7320	1	0.7472	1
A_5	0.4570	17	0.4507	18
A_6	0.6645	5	0.6868	3
A_7	0.5470	12	0.5650	10
A_8	0.5635	10	0.5374	13
A_9	0.4558	18	0.4692	17
A_{10}	0.6477	6	0.6677	4
A_{11}	0.5174	14	0.5426	11
A_{12}	0.6274	7	0.6090	7
A_{13}	0.5540	11	0.5385	12
A_{14}	0.6927	2	0.6996	2
A_{15}	0.6014	8	0.5935	9
A_{16}	0.4886	15	0.4877	15
A_{17}	0.5440	13	0.5355	14
A_{18}	0.5868	9	0.5943	8

In the last stage, the performance ranking was determined according to the decreasing order of grey relationship degrees. In Table 12, the ranking of country performances is made in 2 different ways. In the first case, criteria weights were not taken into account (all criteria were equally weighted), whereas in the second case, the weights were taken into account. When the weights are taken into consideration, the country ranking is $A_4 \succ A_{14} \succ A_6 \succ A_{10} \succ A_1 \succ A_2 \succ A_{12} \succ A_{18} \succ A_{15} \succ A_7 \succ A_{11} \succ A_{13} \succ A_8 \succ A_{17} \succ A_{16} \succ A_3 \succ A_9 \succ A_5$. The best-performing countries according to the weighted ranking are Australia, China, Japan, South Korea, and Germany. In the other case (unweighted), the order is $A_4 \succ A_{14} \succ A_2 \succ A_1 \succ A_6 \succ A_{10} \succ A_{12} \succ A_{15} \succ A_{18} \succ A_8 \succ A_{13} \succ A_7 \succ A_{17} \succ A_{11} \succ A_{16} \succ A_3 \succ A_5 \succ A_9$. Although their rank has changed, there has been no change in the countries in the top two. Table 13 and Figure 6 show the ranks obtained for both cases. In the last column, the final ranks determined by considering these two rankings are shown. For the final ranking, both rankings were averaged and the final ranking was determined according to the dominance status. The dominance status was taken into account if the mean rank was equal, and the country with the better-weighted ranking value was written higher in the ranking. For example, the rank averages of Germany and the USA are equal. However, in terms of weighted ranking, Germany outperforms the USA.

Table 13. Final ranking

Abbreviation	Country	Weighted Rank	Unweighted Rank	Final Rank
A_4	Australia	1	1	1
A_{14}	Japan	2	2	2
A_6	China	3	5	3
A_1	Germany	5	4	4
A_2	USA	6	3	5
A_{10}	South Korea	4	6	6
A_{12}	United Kingdom	7	7	7
A_{18}	Saudi Arabia	8	9	8
A_{15}	Canada	9	8	9
A_7	Indonesia	10	12	10
A_{13}	Italy	12	11	11
A_8	France	13	10	12
A_{11}	India	11	14	13
A_{17}	Russia	14	13	14
A_{16}	Mexican	15	15	15
A_3	Argentina	16	16	16
A_9	South Africa	17	18	17
A_5	Brazil	18	17	18

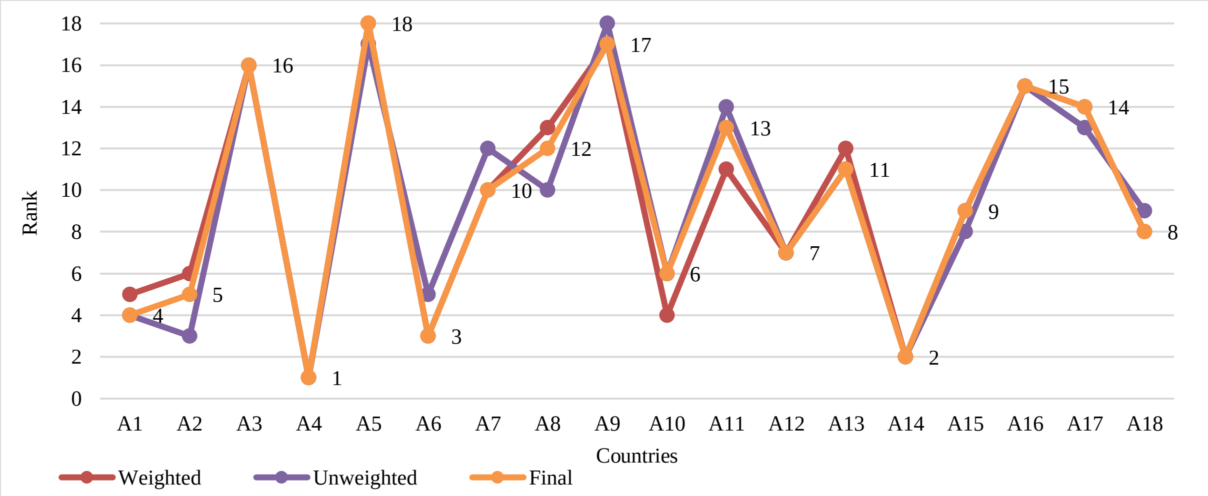

***Figure 6.** Final ranks of countries*

Here, a performance evaluation has been made by considering the COVID-19 pandemic (MC_1) and economic data (MC_2), healthcare system (MC_3), and government precaution (MC_4) rather than the development levels of the countries. The most important reason for this is that this epidemic, which has been effective worldwide since March 2020, significantly affects the economies and health systems of countries. The difficulties in vaccine production and distribution and the different characteristics of the newly emerging and country-specific variants of the virus have also significantly influenced the change in the ranking. Of course, at this point, perhaps the most important factor affecting the ranking is the reliability of the information provided by the countries about COVID-19.

V. CONCLUSION AND RECOMMENDATIONS

The COVID-19 pandemic, which first appeared in the People's Republic of China at the end of 2019 and then spread rapidly to the rest of the world, has become one of the most dangerous epidemics seen in the last century. Unfortunately, millions of people lost their lives due to this disease, which could not be fully suppressed despite the past two years and continued its effects with different mutations. To cope with this disease, hundreds of scientists continue to work on vaccines and drugs in different parts of the world. In addition, many people working in different disciplines carry out studies on the effects of the pandemic on economic and social life.

In this study, the performance of countries against the epidemic during the COVID-19 pandemic was evaluated. For this purpose, 12 criteria included in four main criteria were used for performance analysis with the help of equal-weighted and CRITIC-based Grey Relational analysis. When the results are examined, it is seen that the level of economic prosperity and the government's precaution against the pandemic directly move the countries to an advantageous point. Countries with a relatively low level of economic welfare compared to other countries, unfortunately, appear to be in the lower ranks in the ranking. On the other hand, despite their wide economic opportunities, countries such as Italy, France, and Canada, which have elderly populations, are among the other findings that rank lower in the ranking due to their high mortality rates. From this point of view, it can be concluded that socioeconomic conditions must also be improved for the fight against COVID-19 to be effective. Of course, the study results have the quality of gaining a perspective rather than a comprehensive performance analysis, as they are shaped within the framework of a current subject that is still under investigation. In addition to the factors used, topics such as tourism, psychology, and sociology are among the important factors that should be taken into account. In the future, studies to be carried out with the data that have been confirmed can show the country's performances much more clearly.

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