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EFFECTS OF SUSTAINABLE GOVERNANCE TO SUSTAINABLE DEVELOPMENT

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Abstract: *Sustainable development advocates effective and efficient planning of both present and future use of resources. Governance, on the other hand, is based on the joint and coordinated management of multidimensional variables, which is the basis of the sustainability approach. This study aims to determine how much sustainable governance influences the fulfillment of multidimensional sustainable development. Multiple regression analysis was used to determine the variables that reveal the impact of governance on development in terms of sustainability while the gray relational analysis method was used to rank the countries. The results reveal that increases in the number of people using the internet in society, as well as in the levels of developments in e-government and human development, environmental performance, and political reform, all assist countries achieve their SDGs. Furthermore, it was found that governance has a positive and significant impact on SDGs. In addition, an MCDM model consisting of BWM and gray relational analysis was used to evaluate countries based on their performance in sustainable development, the economic, governance and environment. The gray relational analysis results, on the other hand, revealed that developed and wealthy countries ranked first, while underdeveloped countries experiencing instability, such as war and conflict, ranked last. The Nordic countries outperform other countries in terms of governance and sustainability, depending on the strength of their democracy and executive capacity.*

Key words: *Sustainable Development, Sustainable Governance, Best Worst Method, Gray Relational Analysis.*

1. Introduction

Production and consumption needs have become more prominent as development resources because of the rise of industrialization, excessive resource

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use, and environmental degradation have been criticized as the main culprits (Caradonna, 2014). The considerable rate of economic expansion experienced during the "Golden Age of Capitalism" (Marglin & Schor, 1991; Middleton, 2000; Skidelsky, 2009), particularly following the Second World War, underscored the necessity to strike a balance between development and the environment (Caradonna, 2014). The development of sustainability and governance initiatives has been accelerated by factors such as increased competitiveness and development on a global, regional, and local scale, diversification of commercial and public sector service provision, and the avoidance of climate change and pollution. Sustainable development has become a key idea while addressing issues in different fields, and governance indicators have been used as solution tools (Meadowcroft, 2007).

The global ecosystem, on the other hand, is negatively impacted by global population growth and the resulting increase in production and consumption requirements. For example, the world population, which was around four billion in 1975, has almost doubled to 8 billion by 2021 (Worldometer, 2021). This massive increase has several negative consequences for the environment, including global warming and climate change. Therefore, the importance of future population, production, and consumption control and transformation into planned sustainable development has resurfaced. There are also global obstacles such as education and health issues, poverty, inequality, and the recent COVID-19 pandemic, all of which have a negative impact on the development of all countries. To achieve the Sustainable Development Goals (SDGs), it is essential to solve these problems and use resources wisely. Moreover, it has once again become apparent that countries must collaborate and coordinate their efforts to attain these goals (Barbier & Burgess, 2020). The study focuses on the impact of governance on the sustainability of development, which is linked to systematic and planned development (sustainable development). Furthermore, the variables presented in this study are used to assess the relationship and change of sustainable governance to sustainable development. As a result, the purpose of this study is to examine how the independent variables connected to sustainable governance affect the variable of sustainable development.

In this study, regression analysis will be used to determine the ones that are effective on sustainable development among sustainable governance indicators. Regression models, on the other hand, reflect the existence and degree of relationships between variables, but they cannot reveal the superiority of the countries, which are the study's units, over one another. A multi-criteria decision model will be used to assess countries' performance in terms of both sustainable governance and sustainable development in this context. It will be possible to provide policy suggestions as a result of the multi-criteria decision analysis by determining the positive features of the prominent countries and the negative features of the remaining countries. As a result of the application of the regression model and the multi-criteria decision model, a holistic evaluation will be provided. To determine the causality and effect levels between the variables, multiple regression analysis (MRA) will be used. Gray Relational Analysis (GRA) will be used to rank countries' performance in terms of sustainable development and governance. GRA was selected for the study because it provides a comparable solution to the references to be determined in the criteria. In addition, the Best-Worst Method (BWM) was chosen to determine the weight values of the criteria because it provides consistency with fewer pairwise comparisons than other methods in the literature.

There is a positive and statistically significant association between sustainable governance and sustainable development, according to the literature. To put it another way, as countries' levels of sustainable governance increase, so do their degree of sustainable development. It is critical for countries to concentrate on sustainable governance policies to achieve long-term sustainable development. Studies on sustainable development, which fall under the category of quantitative analysis, have mostly been the focus of investigations[1] in domains such as economics, business, the environment, and energy. However, no research has been found that analyzes the link between sustainable governance and sustainable development. Some studies have specifically explored the relationship between governance and sustainable development (Meadowcroft, 2007; Kardos, 2012; Stojanović et al., 2016; Davis, 2017; Güney, 2017; Omri & Ben Mabrouk, 2020). Others have investigated the link between one facet of sustainable development and the quality of governance (Rajkumar & Swaroop, 2008; Farag et al., 2013; Jindra & Vaz, 2019). None of these studies focused on the role of sustainable governance in achieving sustainable development and evaluated them from the perspective of public administration. Accordingly, this study offers significant contributions to the empirical literature on the interaction between environmental, economic, social, political, and technological variables, which are the components of sustainable governance, and sustainable development. The study seeks to explore the existence of a connection between economic, technological, human, and legal development in sustainable governance and sustainable development. We also look at the variables which may be considered to have a substantial effect among the variables often considered in this area. Do the rankings determined using GRA differ between developed, emerging, and underdeveloped (high, medium, and low level) countries? This study is primarily based on the responses to these two questions, as well as the related evaluations. In addition, the study incorporated data from 149 high, middle, and low-income nations from a variety of international agencies. The data for the study's independent variables were compiled by merging current data from international institutions. In this regard, the study stands out for its inclusiveness and for contributing to the field in a current manner. According to the results of the research, individuals using the internet in society and in e-government development contribute to SDGs. Similarly, human development, environmental performance, and political transformation have all had a favorable impact on the SDGs. Governance, in addition to all these variables, has been shown to have a substantial impact on SDGs.

First, the background of sustainable development will be examined in the chapters of this study and a theoretical framework will be developed for the link between sustainable governance and sustainable development. Second, information on the dimensions affecting sustainable development and sustainable governance will be provided. Then, the research method, research findings, and their interpretation are included. Finally, the research findings are evaluated.

[1] For these studies, see: (Stojanović et al., 2016; Davis, 2017; Güney, 2017; Glass & Newig, 2019; Jindra & Vaz 2019; Omri & Ben Mabrouk, 2020).

2. Literature

Following the 1970s, the topic of sustainability has been a major topic in a variety of sectors, particularly in the environment and economy. Meeting the requirements emerging from rapid population expansion, utilizing resources evenly, and safeguarding the natural environment have all been recognized as issues of research in the context of sustainable development (Harborth, 1991). The substantial increase in consumption, rapid population expansion, and economic growth in this period had severe consequences on the natural environment, causing environmental problems to reach a worldwide scale (Meadows et al., 1972; Turner, 2008). As a consequence, the necessity for a balanced interaction between development and the natural environment has emerged, prompting solution proposals for "sustainable future planning." Sustainable development has been frequently used as a solution tool in this context since the 1980s. This notion has been evaluated in particular by associating it with economic progress in the face of global difficulties, efficient use of natural resources, and resolving social and environmental challenges. In this context, the literature will be discussed in the study in several subsections.

2.1. The evolution of the sustainable development concept

In the literature, there is no one, agreed-upon definition for the terms sustainability and sustainable development. The way researchers approach the subject may differ in both concepts. However, sustainability can be defined as the continuing of something that already exists (Meadowcroft, 1997). Sustainability is conceptually linked to a wide range of themes in the literature. In this context, studies for the welfare of future generations, equality policies for the fair distribution of incomes across generations, studies for global environmentalism, and biodiversity policies for maintaining the ecological balance are some of these issues (Basiago, 1999).

Sustainability research has been performed in a wide variety of fields, including economic (Jackson, 2009), financial (Quayes, 2012), environmental (Goodland, 1995; Morelli, 2011), social (Torjman, 2000), political (Patashnik, 2003), socio-cultural (Chiu, 2004), corporate (Bansal, 2005), digital (Funk, 2015; Gouvea et al., 2018) and urban (Alberti, 1996). Moreover, the studies on the relationship between digitalization, or technological transformation, and sustainability (Funk, 2015; Gouvea et al., 2018; Kostoska & Kocarev, 2019; del Río Castro et al., 2020) have exploded in popularity in recent years. In this context, a group of academics has drawn attention to the link between digital transformation, big data, and sustainable society, and have proposed the "Digital Transformation and Sustainability" model for achieving sustainable development (Pappas et al., 2018). Furthermore, while some researchers proposed models for studies in various fields related to sustainability (Boulanger & Bréchet, 2005; Bebbington et al., 2007), others drew attention to criticisms on various issues related to sustainable development (De Graaf et al., 1996; Marcuse, 1998; Robinson, 2004).

Sustainable development has been characterized in the literature as a crucial concept that "solves all problems" (Fischer-Kowalski & Haberl, 1998), and various scientific studies have been conducted on this subject (Barbier, 1987; Harborth, 1991; Harris, 2000; Ciegis et al., 2009). Economic, social, and environmental/ecological policies are all evaluated equally and simultaneously at all stages of sustainable development in this framework (Basiago, 1999; Harris, 2000; Bell & Morse, 2003; Ciegis et al., 2009). To put it another way, research on sustainable development often emphasizes that it is not possible to achieve sustainable development solely through economic efficiency (Garrod & Fyall, 1998; Harris, 2000; Ciegis et al., 2009; Morelli, 2011). In this context, sustainable development attempts to construct a multidimensional and socioeconomic system that considers factors like income, education, living standards, and health (Ciegis et al., 2009). On the other hand, there is a discussion of strong and weak sustainability in terms of the fact that resources can be substituted or not substituted according to their original forms in appropriate situations. The key topic of discussion in this context is the contrasts in sustainability between the environment and the economy (Ayres et al., 2001). As a result, the concept of sustainable development is a fundamental concept that may be applied to a wide range of fields and different perspectives.

The notion of sustainable development was used particularly in terms of industrialized countries' ability to achieve balanced growth and effective resource management in all sectors, including the environment, the economy, and security (McKenzie, 2004). The UN World Commission on Environment and Development's report "Our Common Future[2]" in 1987 provided the most comprehensive and widely acknowledged explanation of the idea of sustainable development (Basiago, 1999). The notion of sustainable development is defined in the report as "development that seeks to meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Besides, after the publication of this report, the idea of "sustainable development" has become a contentious and vital topic in the public debate (Mitcham, 1995). Another key feature of the aforementioned report is that it emphasizes the significance of establishing justice (equality between generations) between present and future generations, not merely on the basis of economic efficiency in-country growth or development (Garrod & Fyall, 1998). As a result, rather than focusing on a one-dimensional and limited view of growth, a multidimensional and inclusive development model was highlighted.

On the issues of environment and development, the "UN Conference on Environment and Development," also known as the "Rio Conference," was held in 1992. In 1993, the United Nations Commission on Sustainable Development was founded. Various conferences, summits, and forums were organized in the following years to discuss decisions on sustainable development and environmental protection.

The "Millennium Development Goals" (MDGs), which support country development and were implemented between 2000 and 2015, were one of the most important moves done in recent years in terms of sustainable development. In the period 2001-2015, the MDGs made some progress in developing countries. Developed and underdeveloped countries, on the other hand, painted a picture of development that fell far short of expectations throughout the same time period (Sachs, 2012). SDGs that broaden the scope and limitations of the MDGs has come to the fore in the UN as of the end of this period (Biermann et al., 2017). In contrast to

[2] The Report, commonly known as the Brundtland Report, addresses worldwide problems and solutions for the common future.

previous development goals, SDGs include more comprehensive and holistic aims as well as a vision of progress (Le Blanc, 2015; Fukuda-Parr, 2016). In 2015, the "UN Sustainable Development Summit[3]" on sustainable development took hold in addition to all of these events. At this Summit, 17 SDGs were adopted, with all member states committing to achieving them between 2015 and 2030. These goals are made up of 17 major goals and 169 sub-goals that have been endorsed as an urgent call to action by all UN member states. In this framework, it aims to overcome global challenges on important issues such as education, poverty, inequality, climate change, global warming, environmental degradation, economic growth and innovation, peace, and justice, which are relevant to all countries and should be implemented[4] (UN General Assembly, 2015). In addition to these issues, the COVID-19 outbreak is still affecting humans worldwide as of 2020. During the pandemic process, all countries' ability to reach their 2030 goals, especially economic growth, has been interrupted.

2.2. The sustainable governance and sustainable development: What's the connection?

The term "governance" refers to multidimensional management involving formal and informal actors (Huther & Shah, 1998; Hyden et al., 2004; Gündoğdu, 2020). The concept was officially used for the first time in the World Bank's 1989 report on Africa's development. This report emphasized the importance of under-developed and developing countries having proper governance processes or mechanisms to develop by creating a link between development and governance (World Bank, 1989). Moreover, the notion of governance was used to relate to the concepts of accountability, openness, and transparency in a 1992 report from the same agency (World Bank, 1992). Several international agencies, including the UN, the OECD, and the IMF, have used the concept of governance in the years afterward. The UN's "MDGs" and research on the issue underline the relevance of the idea of "governance" (UN, 2007).

Some researchers have attempted to explain the definition of governance in the literature (e.g., Huther & Shah, 1998; Pierre, 2000; Hyden et al., 2004; Benz, 2007; Treib, Bähr & Falkner, 2007; Bevir, 2009; Osborne, 2010). Treib, Bähr, and Falkner (2007) define governance as a multidimensional notion that incorporates various actors, processes, structures, and agencies engaged in political decision-making and execution. To put it another way, in order to comprehend governance, the government must be viewed as a "cooperative state," and decision-making procedures must be developed in collaboration with the public, private sector (market), non-governmental organizations, and citizens (Benz, 2007; Osborne, 2010). In this regard, governance emphasizes the coordination, cooperation, and harmony of actors at all levels (Pierre, 2000). Besides, Gündoğdu (2019) stresses that multi-level governance and participatory democracy will evolve as a collaborative strategy involving numerous actors.

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[3] Every year, the UN General Secretariat also publishes a "report" on the SDGs, which covers current progress.
[4] In addition, there is a sustainable development index/indicator that ranks and evaluates countries based on the SDGs (Kroll, 2015).

The concept of sustainable governance is defined as “socio-political governance processes that contribute to the realization of sustainable development” (Meadowcroft, 2007). As a result, sustainable governance plays a significant role in the sustainable management of various actors (Awuzie & Monyane, 2020) as well as the achievement of countries' long-term goals (Aytekin & Gündodu, 2021). Governance, in particular, is critical to achieving the SDGs and overcoming global issues (UN, 2012).

The "sustainable governance index" is a crucial tool for measuring a country's level of sustainable governance. The sustainable governance index and the SDGs are complementary in this context. For example, in order to achieve strong and sustainable governance, countries have to overcome issues such as economic globalization, social inequality, climate change, resource scarcity, and demographic transition (Brusis & Siegmund, 2011). For the SDGs, a similar explanation applies. In this context, an answer is sought to the extent to which countries are successful in economic, social, and environmental policies, both in the sustainable governance indicators and in the SDGs.

There have been studies that show that there is a theoretical link between sustainable development and governance (Kemp, Parto & Gibson, 2005; Sachs, 2012). Several studies have concluded that using a sustainable governance approach to natural catastrophes and crisis management is critical in this context (Ahrens & Rudolph, 2006; Ansell et al., 2010; Tierney, 2012). Some studies, according to Rothstein and Teorell (2008), underline that there is a significant relationship between economic growth and governance, which they regard as a critical component of development. Similarly, in previous research on the ties between sustainable development and sustainable governance, economic, social, and ecological factors, as well as relationships between official and non-official agencies, have been mentioned (Spangenberg, 2002; Meadowcroft et al., 2005).

Various studies have been conducted examining the impact of governance on development outcomes. In this context, it has been discovered that in countries with a high level of governance, it has a regulatory and considerable effect on public health and primary education expenditures (Rajkumar & Swaroop, 2008; Farag et al., 2013). According to certain studies, there is a strong link between a country's per capita income and its degree of governance quality (Campos & Nugent, 1999, Kaufmann et al., 1999; Kaufmann et al., 2010; Fayissa & Nsiah, 2013). As a result, it has been stressed that governance is critical to a country's development and attainment of higher wealth levels (Oster, 2009). Another study concluded that, in the next years, sustainability will make more positive development if governance worldwide improves (Joshi et al., 2015). In other studies, the relationship between corruption prevention, which is a component of governance, and sustainable development has been investigated, and it has been discovered that there is a negative relationship between increased corruption and sustainable development (Aidt, 2009; Bentzen, 2012). Additionally, Lennan and Ngoma (2004) stressed the significance of institutional capacity building to support good governance and sustainable development.

The literature-based on quantitative analysis (Rajkumar & Swaroop, 2008; Stojanović et al., 2016; Davis 2017; Güney, 2017; Glass & Newig, 2019; Omri & Ben Mabrouk, 2020) emphasizes that there is a multidimensional relationship between sustainable development and governance. In this context, Stojanović et al. (2016) used the World Bank governance indicator data set to establish the relationship between sustainable development and governance. Davis (2017) has examined the associations between good governance and human development indicators in Sub-Saharan Africa. Güney (2017), on the other side, used the Adjusted Net Saving indicator to examine the relationship between sustainable development and governance in 121 countries using data spanning the years 1996 to 2012. Moreover, Jindra and Vaz (2019) discussed the relationship between multidimensional poverty prevention, which is a component of sustainable development, and governance quality. Glass and Newig (2019) used multiple governance indicators (participation, policy coherence, reflexivity, adaptation, and democratic institutions) to examine SDG achievement in 41 high and upper-middle-income countries. Finally, Omri and Ben Mabrouk (2020) analyzed data on governance and sustainable development from 1996 to 2014 to study countries in 20 MENA (Middle East and North Africa-) areas. As can be seen from all these studies, it is desirable to analyze and quantify the institutional development and governance quality of countries based on certain variables in studies where sustainable development and governance indicators are accepted as data. Ultimately, it has been underlined that the relationship between sustainable development and governance is multidimensional and interdependent.

3. Methodology

The study's aim is to obtain a comprehensive evaluation based on the results of two different models. The MRA will be used to investigate the relationship between sustainable development and sustainable governance in this context. Countries are the units considered in the MRA. The BWM-GRA multi-criteria decision model will be used to assess the countries' sustainable development and governance performance. Figure 1 depicts the methodology used in the study.

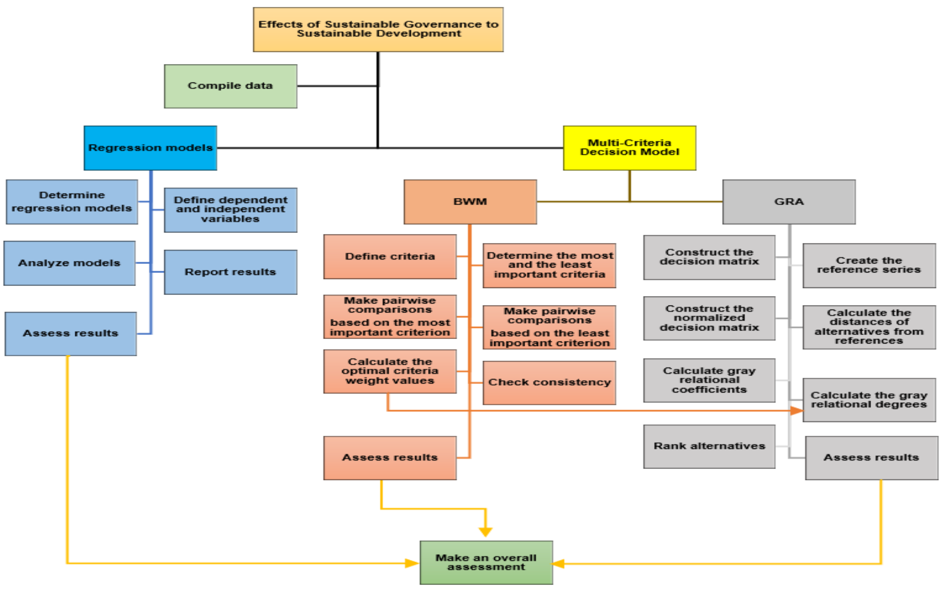

Figure 1. The scheme of methodology

Different variables or indicators are used to measure sustainability goals and the dimensions associated with these goals, as shown by the literature (Munda and Nardo, 2005; Gasparatos et al., 2008; Wu and Wu, 2012; Diaz-Balteiro et al., 2017; Croissant and Pelke, 2022). However, the relative superiority, validity, and reliability of these various indicators and data are debatable. Because of this problem, researchers have looked for a single variable/criterion from sources that measure the same variable/criterion with different units. For this reason, data collected from various sources with the aim of measuring the same variable were standardized and integrated. As a result, data that was comparable and clear of measurement differences were created.

The study was done using data collected from a variety of sources (BTI, 2021; Data World Bank, 2021; Freedom House, 2021; Human Development Reports, 2021; SDGs Database, 2021; SGI, 2021; The Economist Intelligence Unit, 2021; Worldometer, 2021; WVS, 2021; WJP, 2021). In this context, Political Transformation, Political Participation, Rule of Law, Quality of Democracy, Political Integration, Economic Transformation, and Governance variables were created using various indicators, and data sources. The normalization process was used to eliminate data measurement differences and create a one-dimensional data frame that was comparable. Eq. (1) has been applied in this context.

$$z_{ij} = \frac{x_{ij} - x_{-j}}{x_{*j} - x_{-j}} \tag{1}$$

In Eq. (1), the best value in the related indicator is x_{*j}, while the worst value is x_{-j}. Because of the normalization process, the best value is 1 and the worst value is 0 in the indicators. In the variables formed by integrating more than one indicator, the arithmetic average of the normalized values of the relevant indicators was used. Table 1 shows the indicators that were used to form the variables.

Table 1. Indicators and variables

Notation	Variables/Criteria	Indicators
C1	SDG	SDG Index
C2	Political Transformation	BTI-Stateness, SGI-Executive Capacity, WGI-Political Stability and Absence of Violence/Terrorism, WGI-Government Effectiveness, WGI-Regulatory Quality
C3	Political Participation	Freedom House-Freedom Index, BTI-Political Participation, SGI- Citizens' Participatory Competence
C4	Rule of Law	WGI-Rule of Law, WJP- Rule of Law Index, BTI-Rule of Law, SGI-Rule of Law
C5	Quality of Democracy	BTI- Stability of Democratic Institutions, SGI-Quality of Democracy
C6	Political Integration	BTI-Political and Social Integration, SGI- Social Policies
C7	Economic Transformation	BTI- Economic Performance, SGI-Economic Policies
C8	Governance	BTI-Governance Index, SGI-Governance

C9	HDI	HDI
C10	Democracy Index	Democracy Index
C11	CPI	CPI Score
C12	E-government	E-Government Index
C13	EPI	EPI
C14	CO2 Emissions	CO2 emissions (metric tons per capita)
C15	GDP Growth	GDP growth (annual %)

The effects of governance variables on the SDG will be investigated using regression analysis in this study. The variables C1-C8 in Table 1 will be used in the regression analysis in this context. Also, countries will be ranked according to their levels of sustainable development and sustainable governance using Gray Relational Analysis, one of the multi-criteria decision-making methods. C1-C15 criteria will be considered in GRA evaluations. As a result, it aims to provide a more comprehensive assessment. In the following part, it will be given some explanatory information about MRA, and GRA used in this study.

3.1. Multiple Regression Analysis

The regression analysis is a collection of procedures that uses one or more independent variables to explain changes in a dependent variable. At the end of this process, the model specified in Eq. (2) is obtained where dependent variable is Y, independent variables are X_i, constant term is β_0, regression coefficient of p variables are β_p, error term is ε, and p=1,...,k (Tabachnick & Fidell, 2013; Kalaycı, 2014; İslamoğlu & Alnıaçık, 2014).

$$Y = \beta_0 + \beta_p X_p + \varepsilon \tag{2}$$

In Eq. (2), ε denotes the error caused by variables that were not included in the analysis for various reasons, whereas β_0 represents the value of the dependent variable when all the independent variables regression coefficient values in the model are zero. The null hypothesis that all regression coefficients for the p independent variable are equal to zero and the alternative hypothesis that at least one regression coefficient is different from zero are both tested in multiple linear regression analysis. The t-test is used to determine the singular significance of the specified parameters, while the F-test is used to determine the model's overall significance. The assumptions of normal distribution, linearity, zero mean of error terms, constant variance, no autocorrelation, and no multiple correlations must all be met in multiple linear regression analysis. Additionally, the level of explanation of the change in the dependent variable of the independent variables included in the model can be calculated as a percentage using the coefficient of determination, R^2. If the model contains many independent variables, the adjusted coefficient of determination, ΔR^2, is used instead of R^2 (Tabachnick & Fidell, 2013; Kalaycı, 2014; İslamoğlu & Alnıaçık, 2014).

Among the recent studies in which the MRA has been used, we can indicate financial risk measurement and prediction (Valaskova et al., 2018), evaluating the impact of corporate social sustainability culture on financial success (Schönborn et al., 2019), the influence of different aspects of governance, namely participation, policy coherence, reflexivity, adaptation and democratic institutions on SDG achievement (Glass & Newig, 2019), determining the factors influencing the integration of sustainability indicators into a company's performance management system (Zharfpeykan & Akroyd, 2022), and investigating the factors attracting the population (Kokubun, 2022).

3.2. Best-Worst Method

Weighting processes are used to determine the importance levels of the criteria on the solution of multi-criteria decision problems. There are numerous methods for determining criteria weighting based on the data structure of a decision matrix or subjective evaluations of experts/decision-makers. Subjective weighting techniques based on pairwise comparisons are frequently used in this context. BWM, one of the pairwise comparison methods, will be used in this study. In general, for n criteria, n(n-1)/2 comparisons are usually required in the pairwise comparison-based techniques. The large number of pairwise comparisons appears to be a significant impediment to effective weighting, especially in problems with a large number of criteria. When compared to the commonly used AHP (Analytic Hierarchy Process), which provides weighting with pairwise comparisons, BWM allows the weighting process to be completed with fewer pairwise comparisons. FUCOM (Full Consistency Method), which has a similar structure to BWM, prevents inconsistency in expert evaluation and ensures complete consistency. However, BWM allows for pairwise criteria comparisons in the context of the most and least important criteria. As a result, BWM was preferred because it allows comparison with both the least important and most important criteria, making the expert feel at ease with the evaluations. Furthermore, BWM, like FUCOM, allows for the measurement of consistency analysis using a mathematical programming model and reduces pairwise comparison inconsistency (Rezai, 2015; 2016; Aytekin, 2020). On the other hand, BWM provides weighting based on the subjective assessments of experts or decision makers. As a result, it is lacking in objectivity. BWM also employs Saaty's 1-9 Fundamental Scale. Criticisms of the Saaty Fundamental Scale are valid for BWM. In the study, BWM will be used to obtain criteria weight values based on expert judgments in a way that minimizes inconsistency. BWM has recently been used to solve decision problems such as wagons for the internal transport (Stević et al., 2017), evaluating financial performance of companies (Aytekin, 2020), off-road vehicle selection (Pamučar & Savin, 2020), supplier selection for biofuel companies (Kazemitash et al., 2021), analyzing barriers to industrial sharing economy (Govindan et al., 2020). Implementation steps of BWM are outlined below (Rezai, 2015; Rezai, 2016; Aytekin, 2020).

Step 1: Determine the criteria to be used: The criteria that will be used to solve multi-criteria decision-making problems are identified.

Step 2: Determine the most important and the least important criteria: Among the criteria, the most important (the best) and least important (the worst) criteria are determined. B denotes the most important criterion, while K denotes the least important criterion.

Step 3: Make pairwise comparisons of criteria based on the most important one: The Saaty 1-9 Fundamental Scale is used to determine the importance level of the most important criterion in relation to other criteria, and the vector in Eq. (3) is created.

$$A_B = \left(a_{B1}, a_{B2}, \ldots, a_{Bn}\right) \tag{3}$$

When using Saaty's 1-9 Fundamental Scale to determine the importance level of B according to the j criterion, a value of 1 indicates equal importance, a value of 2 indicates very little importance, and a value of 3 indicates a little more importance. Similarly, a value of 4 denotes more than a little importance, a value of 5 denotes strong importance, a value of 6 denotes slightly more than strong importance, a value of 7 denotes very strong importance, a value of 8 denotes more than very strong importance, and a value of 9 denotes absolute importance (Saaty, 1977; Aytekin & Durucasu, 2020).

Step 4: Make pairwise comparisons based on the least important criteria: The Saaty 1-9 Fundamental Scale is used to determine the importance levels of the criteria other than the least important criteria in relation to the least important criteria, and the vector in Eq. (4) is created.

$$A_K = \left(a_{1K}, a_{2K}, \ldots, a_{nK}\right)^T \tag{4}$$

Step 5: Calculate the optimal criteria weight values: The weight values of the criteria are determined using the linear programming model in Eq. (4). The aim of this process is to make the largest of the $\left|\frac{w_B}{w_j} - a_{Bj}\right|$ and the smallest of $\left|\frac{w_j}{w_K} - a_{jK}\right|$ differences for each j criterion. The purpose of Equation (5) is to find criterion weights that minimize the value of ξ.

$$\begin{aligned}
& Min\ \xi \\
& Subject\ \text{to} \\
& \left|\frac{w_B}{w_j} - a_{Bj}\right| \le \xi, \forall j \\
& \left|\frac{w_j}{w_K} - a_{jK}\right| \le \xi, \forall j \\
& \sum_{j=1}^{n} w_j = 1 \\
& w_j \ge 0, \forall j
\end{aligned} \tag{5}$$

Step 6: Check consistency: In this step, the consistency of pairwise comparisons of criteria is determined. ξ shows the model's inconsistency in Eq. (5). As a result, it is tried to achieve high consistency criterion weight values. Rezai (2016) proposed the consistency index (CI) in Table 2 for the control of consistency in the context of the importance level of the most important criterion relative to the least important criterion (a_{BK}).

Table 2. Consistency Index

a_{BK}	1	2	3	4	5	6	7	8	9
CI (enb ξ)	0,00	0,44	1,00	1,63	2,30	3,00	3,73	4,47	5,23

Table 2 shows the maximum acceptable ξ values based on the number of criteria. The fact that the objective function ξ value obtained from solving the model in Equation (4) is less than the value in Table 1 indicates that the comparisons are consistent. Also, the consistency ratio (CR, or ξ*) given in Eq. (6) can also be used for consistency analysis.

$$CR = \frac{\xi}{CI} \quad (6)$$

While the CR value is between 0 and 1, it is important to note that consistency increases as it approaches 0, and inconsistency increases as it approaches 1. BWM is said to produce more consistent and reliable results than other weighting techniques (Rezai, 2015; Rezai, 2016).

3.3. Grey Relational Analysis

Julong (1989) proposed Gray System Theory to solve problems with insufficient or uncertain information. Gray System Theory is based on the idea that understanding a system is insufficient to construct a relational analysis or a model to characterize it. Gray is employed to express uncertain or incomplete information in this theory. White denotes the possession of certain/complete information, while black denotes the absence of such information. Systems analysis, data processing, modeling, forecasting, decision making, and control are all fields where Gray Theory is applied. Gray Relational Analysis (GRA) is a form of quantitative analysis that involves the evaluation of alternatives and is used in the field of decision making. At this point, Gray Theory, like Fuzzy Set Theory, has a mathematical structure that can process weak information (Julong, 1989; Wu, 2002; Lin & Liu, 2004; Sallehuddin et al., 2008; Tzeng & Huang, 2011).

As previously stated, the data used in the evaluation of countries was compiled from various sources and normalized. The values of the indicators in such data are difficult to interpret. In other words, as the values of an indicator rise, the level of sustainability rises or falls, but there is no direct equivalent of this value. As a result, the Gray Relational Analysis method, which allows for the creation of a comparability series known as a reference series, was chosen for the study by taking into account the performances of the alternatives with incomplete information. The reference series is used to calculate the gray relational coefficient values for the alternatives. Finally, the gray relationship degrees are calculated using these values. If an alternative has the highest gray relational degree with the reference series, it means that the corresponding alternative is the most similar to the reference series and will be the best choice (Liu et al., 2013; Biswas et al., 2014). However, problems can arise when using the normalization operation, which is commonly used in GRA, in decision matrices containing some data structures, such as the reference series value being 0 or greater than the values in the decision matrix (Aytekin, 2021a). Different normalization techniques can be used in this case to generate a comparable decision matrix.

GRA, which is widely used in the field of multi-criteria decision making, provides a solution by defining the ideal values (points) for each criterion in the decision matrix and using this reference series to measure the relational degree of the alternatives. As a result, the alternative with the highest degree of relation is chosen as the solution. GRA might be called a reference-based method because of this basic feature. Furthermore, many integrated decision models and fuzzy derivatives where GRA is used in combination with other multi-criteria decision-making methods can be found in the literature. Supplier selection (Yang & Chen, 2006), determination of the most appropriate parameters in the drilling process (Tosun, 2006), wastewater treatment method selection (Zeng et al., 2007), facility layout (Kuo et al., 2008), sustainable electricity generation planning (Malekpoor et al., 2018), identification of factors affecting Taiwan's economic growth (Huang et al., 2020), and evaluation of countries' climates are examples of decision problems to which GRA is applied (Niazi et al., 2021).

Among the recent studies in which GRA has been used, we can indicate evaluation of healthcare service quality factor (Aydemir & Şahin, 2019), measurement of city sustainability (Yi et al., 2021), investigation of life cycle assessment barriers for sustainable development (Kaswan & Rathi, 2021), evaluation of water quality (Tao et al., 2022), and sustainable industrialization performance evaluation of European Union countries (Candan & Cengiz Toklu, 2022). The GRA process steps can be summarized as follows (Wu, 2002; Tzeng & Huang, 2011):

Step 1. Construct the decision matrix: The decision matrix X indicated in Eq. (7) is constructed where i=1,…,m alternatives and j=1,…,n criteria.

$$X=\begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix} \tag{7}$$

Step 2. Create the reference series: The ideal values for each criterion are determined to generate a reference series (x_{0j}). The reference series can be assigned independently of the decision matrix by the decision maker. The values in the decision matrix, on the other hand, are primarily considered in the GRA implementation, and the best ones are determined as a reference. The reference series is obtained with Eq. (8) if the best values in the decision matrix are used as a reference.

$$x_{0j}=\left\{\left(\max_i x_{ij} \,\middle|\, j\in J^{+}\right),\left(\min_i x_{ij} \,\middle|\, j\in J^{-}\right)\right\} \tag{8}$$

J^{+} denotes for benefit-oriented criterion, while J^{-} shows for cost-oriented criteria in Eq. (8).

Step 3. Construct the normalized decision matrix: The normalized matrix is constructed using Eq.s (4-5), depending on how the ideal values are derived. When a reference is decided in the context of the decision matrix's values, Eq. (9) is used, and when a reference is determined independently of the decision matrix, Eq. (10) is used.

$$x_{ij}^{*}=\begin{cases} \dfrac{x_{ij}-\max\limits_j x_{ij}}{\max\limits_j x_{ij}-\min\limits_j x_{ij}} & , \quad j\in J^{+} \\ \dfrac{\max\limits_j x_{ij}-x_{ij}}{\max\limits_j x_{ij}-\min\limits_j x_{ij}} & , \quad j\in J^{+} \end{cases} \tag{9}$$

$$x_{ij}^{*} = \frac{\left| x_{ij} - x_{0j} \right|}{\max\limits_{j} x_{ij} - x_{0j}} \tag{10}$$

Other reference-based normalization techniques can be used if the operation specified in Eq. (10) does not provide effective normalization under certain decision matrices (Aytekin, 2021a).

Step 4. Calculate the distances between the alternatives from the references: Eq. (11) is used to compute the distances of the alternatives from the reference series using the normalized values, where x_{0j}^{*} is the normalized reference value for the criterion j.

$$\Delta_{ij} = \left| x_{0j}^{*} - x_{ij}^{*} \right| \tag{11}$$

Δ_{ij} represents the distance between the alternative i and the reference series in criterion j in Eq. (11). As a result, the distance matrix Δ will be constructed according to Eq. (12).

$$\Delta = \begin{pmatrix} \Delta_{11} & \cdots & \Delta_{1n} \\ \vdots & \ddots & \vdots \\ \Delta_{m1} & \cdots & \Delta_{mn} \end{pmatrix} \tag{12}$$

Step 5. Calculate gray relational coefficients: To calculate gray relational coefficients, first determine the largest and smallest values in the Δ matrix, as well as the discriminant coefficient (ζ). The largest and smallest values in the Δ matrix are determined using Eq.s (13-14).

$$\Delta_{\max} = \max_{i} \max_{j} \Delta_{ij} \tag{13}$$

$$\Delta_{\min} = \min_{i} \min_{j} \Delta_{ij} \tag{14}$$

The ζ coefficient regulates the relationship between $\Delta_{\min}$ and $\Delta_{\max}$ values by taking a value in the range [0,1]. To put it another way, the range of the ζ coefficient and gray relationship coefficient can be increased or compressed. The ζ coefficient is generally defines as 0.5 for averaging. After determining the ζ, $\Delta_{\min}$ and $\Delta_{\max}$ values, Eq. (15) is used to derive the gray relational coefficients (γ_{ij}).

$$\gamma_{ij} = \frac{\Delta_{\min} + \zeta \Delta_{\max}}{\Delta_{ij} + \zeta \Delta_{\max}} \tag{15}$$

Step 6. Calculate the gray relational degrees: Eq. (16) is used to determine the gray relational degree (Γ_i), which is a measure of how similar the alternatives are to the reference series. It takes into consideration weighting of criteria.

$$\Gamma_i = \begin{cases} \dfrac{1}{n} \sum\limits_{j=1}^{n} \gamma_{ij} & , \quad \text{the criteria are not weighted} \\ \sum\limits_{j=1}^{n} \gamma_{ij} w_j & , \quad \text{the criteria are weighted} \end{cases} \tag{16}$$

Alternative's closeness to the reference series representing ideal solutions is measured by the Γ_i value. As a result, the problem's solution is finished by ordering the alternatives from largest to smallest based on the Γ_i values.

4. Results

MRA is used to examine causality relationships in this study, which is discussed in the context of sustainable governance and development. The countries were then evaluated using the GRA in terms of sustainable development and governance. Four different models were used in the MRA analyses, which took into consideration the relationships between independent variables. These models have been used to examine the relationships between various dimensions of sustainable governance and development. Table 3 summarizes the models and analysis findings.

Table 3. Results of MRA

Dependent Variable	SDG	SDG	SDG	SDG
	Technology, Economy, Environment, Social	Political, Economy, Environment, Social	Rule of Law, Economy, Environment, Social	Governance, Economy, Environment, Social
Independent Variables	Model 1	Model 2	Model 3	Model 4
Constant	43.487***	23.732***	48.112***	48.835***
Individuals using the Internet (% of population)	.116***			
Population growth (annual %)		-.746*	-2.399***	-3.031*
GDP per capita (current US$)	2.893E-5	-1,011E-5	-5.784E-5	
GDP growth (annual %)				.439***
CO2 emissions (metric tons per capita)	-.455***	-.373***		
Human Development Index (HDI)		64.527***		
Political Transformation			20.419***	
Political Participation		-3.183		
Political Integration	-1.291	2.943		
E-Government Index	31.406***			
Governance				6.312*
Quality of Democracy			-3.884	
Economist Democracy Index			-.018	
Environmental Performance Index			.303***	.381***
ΔR^2	0.827	0.863	0.765	0.74
F	142.460***	156.569***	81.178***	106.088***

Note: *, **, and *** indicate the significance at 10%, 5%, and 1% levels, respectively.

It is obvious that the relationship between sustainable governance and sustainable development. By focusing on management and governance, the scope of this research has been narrowed. The effects of the economy, environment, and social policies, which are the foundations of sustainable development, are included as dependent variables in all four models in this context. In addition, the independent variables were analyzed for the meaning of technology influence in Model 1, political influence in Model 2, rule of law and democracy effect in Model 3, and governance effect covering all of these in Model 4. The increase in the number of people utilizing the internet in the country, as well as the value of the E-Government Index, had a positive impact on the SDG in Model 1. Countries that have advanced in ICTs (for example, the increase in internet usage rates of countries and the spread of e-participation policies) have also achieved a certain level in terms of sustainable development. Individuals' increased Internet access, in particular, has an impact on their policymaker's ability to be more transparent, democratic, and accountable in front of the public. As a result, citizens' demands for information, consultation, and active participation in the delivery of public services are on the rise. Some of these expectations are being met by the public agencies, particularly through their websites (Gündoğdu, 2021). Indeed, people's expectations for the development of e-government and e-participation opportunities have risen as they increasingly use the internet, smartphones, and social media (ITU-International Telecommunication Union, 2020). As a result, the global expansion of ICTs has had an impact on e-government and digitalization in public administration (Sandoval-Almazan & Gil-Garcia, 2012). In this regard, the findings of the research are consistent with those of other studies that have concluded that digitization has a favorable impact on sustainability (Funk, 2015; Gouvea et al., 2018; Pappas et al., 2018; del Río Castro et al., 2020). Another finding made possible by this model is that increased carbon emissions have a negative effect on the SDGs. To put it another way, countries' sustainable development and technological progress are effective in lowering carbon emissions. In this aspect, the research findings gained are similar to Funk's (2015) and Omri and Ben Mabrouk's research findings (2020).

The increase in the Human Development Index (HDI) as an independent variable and the increase in SDGs are exactly related in Model 2, which we derived by adding the political element influence on the primary components of sustainable development. The results are consistent with previous research (Garrod & Fyall, 1998; Harris, 2000; Ciegis et al., 2009; Morelli, 2011) that emphasizes that evaluating development solely by economic growth is insufficient. The HDI, in particular, is based on three fundamental components: health, knowledge, and income level. These elements emphasize the importance of fulfilling social, economic, and political goals in human development. As a result, sustainable development helps to create a diverse socio-economic system that includes income, education, living standards, and health (Ciegis et al., 2009). The findings support the link between political (political participation + political transformation + political integration) and social factors (HDI). In addition, this finding indicates that studies dealing with the subject of sustainability in political (Patashnik, 2003) and social (Torjman, 2000; McKenzie, 2004) dimensions may be related to each other. Another result of this model is the prediction that as the population grows, sustainable development would decline. The major goal of the sustainable development issue is to come up with answers to the problems that will arise as the world's population grows. As a result, population increase has an impact on many aspects of a country, including production, consumption, social, and environmental variables. There is a direct link between a country's sustainable development and population planning in this context.

The relationship between the rule of law and the SDGs, as well as independent variables, was investigated in Model 3 developed as part of the research. In this context, it has been determined that countries with democratic, free, and independent judicial systems have greatly improved environmental and, in particular, political performance. It has been discovered that there is a positive and significant relationship between political transformation (stateness, political participation, rule of law, democratic institutions, political and social integration) and sustainable development, particularly in these countries. Other research analyzing the relationship between judicial independence and democracy and sustainable development (Stojanović et al., 2016; Güney, 2017; Glass & Newig, 2019; Omri & Ben Mabrouk, 2020) used the rule of law, SDGs, and governance variables. As a result, countries with legitimacy and democratic governance are more likely to achieve the SDGs.

Finally, in Model 4, it was discovered that governance indicators and SDGs had a directly proportional relationship. While achieving the SDGs, it is critical for governments to develop solution policies that analyze the interactions between goals with a broad and holistic governance perspective. Policymakers can solve development problems by implementing a multi-level governance process that includes all relevant stakeholders and follows a transparent, responsible, and effective governance strategy. As a result, governments are advised to develop integrated and coordinated sustainable policies. In this regard, the study, like others (Stojanović et al., 2016; Davis, 2017; Güney, 2017; Jindra & Vaz, 2019; Omri & Ben Mabrouk, 2020), has confirmed that governance has a favorable impact on sustainable development through quantitative analysis. In reality, like Güney's research (2017), the findings of this study demonstrated that as the quality of governance rises, so does the level of sustainable development in both developed and developing countries. The research's original finding is that it indicates a link between several variable groups and sustainable development and governance. The level of governance, on the other hand, should be questioned considering each country's particular characteristics.

A multi-criteria decision-making model was used to evaluate countries in terms of sustainable development and governance. BWM was used to weight criteria in this model. The criteria weights obtained by the BWM method are shown in Table 4.

Table 4. Results of BWM

Criteria	C1	C2	C3	C4	C5	C6	C7	C8
Weights	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955
Importance Rankings	1	9	5	5	5	14	2	2
Criteria	C9	C10	C11	C12	C13	C14	C15	
Weights	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	
Importance Rankings	12	5	13	15	4	10	10	

According to the BWM weighting results in Table 3, the most important criterion was SDG, while e-government was the least important criterion. Also, the CR value specified in Eq. (6) is very close to zero for these comparisons (CR=0.06). Thus, it can be said that a high level of consistency is achieved. Economic, social, and environmental dimensions are the basis of sustainable development (Basiago, 1999; Mitcham, 1995). There are economic, social, and environmental components to the relationship between sustainable development and sustainable governance, as well as certain related institutional dimensions (Spangenberg, 2002; Bansal, 2005; Meadowcroft et al., 2005). Therefore, sustainable development was used as the best criterion in BWM, and the economic, social, and environmental criteria (Economic Transformation, Governance, and EPI) that directly affect the SDG were weighted as criteria near to the best. Other criteria used within the scope of the study were correlated according to their importance.

GRA was used to evaluate countries in terms of sustainable development and governance, and to identify leading and behind countries and make comparisons. The analysis included 149 countries with no missing data in the criteria used in the study. The weight values of the criteria obtained using BWM are included in the GRA processes. Table 5 shows the ranking results obtained by GRA.

Table 5. Results of GRA

Rank	Country	Rank	Country	Rank	Country	Rank	Country
1	Sweden	41	Ghana	81	Nepal	121	Saudi Arabia
2	Denmark	42	Greece	82	Gambia	122	Mauritania
3	Norway	43	Jamaica	83	Côte d'Ivoire	123	Laos
4	Finland	44	Hungary	84	Kuwait	124	Oman
5	Switzerland	45	Romania	85	Bosnia and Her.	125	Myanmar
6	New Zealand	46	Bulgaria	86	Morocco	126	Iraq
7	Germany	47	India	87	Thailand	127	Nigeria
8	Estonia	48	Peru	88	Belarus	128	Nicaragua
9	Uruguay	49	Argentina	89	Rwanda	129	Cameroon
10	United Kingdom	50	Malaysia	90	Burkina Faso	130	Mozambique
11	Ireland	51	Montenegro	91	Kenya	131	Pakistan
12	Netherlands	52	Colombia	92	Jordan	132	Angola
13	Austria	53	Georgia	93	Malawi	133	Afghanistan
14	Canada	54	Armenia	94	Tanzania	134	Eswatini
15	Iceland	55	Brazil	95	P.N. Guinea	135	Congo, Dem. Rep.
16	Czechia	56	North Macedonia	96	Cambodia	136	Iran
17	Australia	57	Albania	97	Sierra Leone	137	Zimbabwe
18	France	58	Serbia	98	Guinea	138	Congo, Rep.
19	Slovenia	59	Dominican Rep.	99	Turkey	139	Eritrea
20	Lithuania	60	UAE	100	Uganda	140	Haiti
21	Costa Rica	61	Ukraine	101	Algeria	141	Cent. Afr. Rep.
22	Belgium	62	El Salvador	102	Niger	142	Burundi
23	Latvia	63	Paraguay	103	Kazakhstan	143	Chad
24	Korea, Rep.	64	Indonesia	104	Guinea-Bissau	144	Venezuela
25	Mauritius	65	Vietnam	105	Honduras	145	Syrian Ar. Rep.
26	Japan	66	Philippines	106	Azerbaijan	146	Libya
27	Spain	67	Sri Lanka	107	Uzbekistan	147	Yemen
28	Chile	68	Ecuador	108	Egypt	148	Sudan
29	Malta	69	Tunisia	109	Ethiopia	149	South Sudan
30	Portugal	70	Senegal	110	Russian Fed.		
31	Slovak Rep.	71	Benin	111	Madagascar		
32	Israel	72	Mongolia	112	Djibouti		
33	United States	73	China	113	Guatemala		
34	Botswana	74	South Africa	114	Gabon		
35	Poland	75	Moldova	115	Mali		
36	Panama	76	Bolivia	116	Zambia		
37	Italy	77	Namibia	117	Togo		
38	Croatia	78	Mexico	118	Tajikistan		
39	Bhutan	79	Bangladesh	119	Liberia		
40	Cyprus	80	Kyrgyzstan	120	Lebanon		

When looked at the findings in Table 5, it's clear that Sweden is in top place and South Sudan is in worst place. Denmark, Norway, Finland, Switzerland, New Zealand, Germany, Estonia, Uruguay, and the United Kingdom also include the top ten countries. Zambia, Togo, Tajikistan, Liberia, Lebanon, Syrian Arab Republic, Libya, Yemen, Sudan and South Sudan include the bottom ten. Sweden's focus on environmental integration and welfare policies in social and political terms might be seen as the cause for its ranking in first place in terms of sustainable development and governance. This country also has adaptable and effective action plans that are economically, environmentally, and socially viable (Government Offices of Sweden, 2021). According to Table 5, several leading European countries (Denmark, Norway, Finland, Switzerland, Germany, and England) have enacted sustainability policies that are similar to Sweden's. The GRA results showed that developed and wealthy countries were first, while underdeveloped countries experiencing instability, such as war and conflict, were last. Also, the countries in the first place are those that are at the top of several international institutions and organizations' indices of economic and democratic development levels. Northern European and Scandinavian countries do better in terms of governance and sustainability than other countries, depending on the strength of their democracy and executive capacity. It should also be stated unequivocally that the economic and social problems caused by the COVID-19 pandemic have severely harmed several countries' political, administrative, and reform capacities.

4.1. Validation of Results and Sensitivity Analysis

Sensitivity analysis is commonly used to evaluate the effects of parameter changes, the reliability, and the validity of multi-criteria decision analysis solutions. Sensitivity analysis can be performed using various approaches, such as changing the weighting coefficients of the criteria, changing the units of measurement in which the values of the alternatives are expressed, changing the scales presenting the linguistic criteria, changing the type of criteria (cost/benefit), and comparing the results obtained by various methods. Most studies, however, conduct a sensitivity analysis based on changes in the weighting coefficients of the criteria and compares similar MCDA methods' results (Biswas, 2020; Durmić et al., 2020; Božanić et al., 2021; Puška et al., 2021; Biswas et al., 2021a; Biswas et al., 2021b; Aytekin, 2022). For this reason, changing criteria weight coefficients and comparing similar MCDA methods' results are used to make sensitivity analysis for the validation of results. The sensitivity analysis on the criterion weight values is used to assess the impact of the most influential criterion on the ranking performance of the proposed model. In this context, to investigate changes in criterion weighting coefficients, fourteen different sets were created. The weight values of the other criteria were changed only once for each criterion to create these sets (Aytekin, 2022). These sets, which include new criterion weight coefficients, are shown in Table 6.

Table 6. The Sets for Changing Criteria Weight Coefficients

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
SET 0	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637
SET 1	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307
SET 2	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637
SET 3	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637
SET 4	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637
SET 5	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637
SET 6	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318
SET 7	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955
SET 8	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955
SET 9	0.0637	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477
SET 10	0.0477	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637
SET 11	0.0101	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477
SET 12	0.0955	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101
SET 13	0.0637	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955
SET 14	0.0637	0.1307	0.0637	0.0637	0.0637	0.0637	0.0318	0.0955	0.0955	0.0477	0.0637	0.0477	0.0101	0.0955	0.0637

Set 0 in Table 6 represents the original weight values obtained using BWM in this study. Table 7 shows the Spearman rank correlation (r_s) results of the ranking results obtained with the sets created with the criterion weight values in Table 6.

Table 7. The values of the Spearman's rank coefficient

	Set 0	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14
Set 0	1	0.994	0.982	0.997	0.990	0.988	0.994	0.987	0.986	0.996	0.992	0.991	0.992	0.992	0.993
Set 1	0.994	1	0.976	0.991	0.986	0.979	0.988	0.987	0.983	0.994	0.987	0.986	0.983	0.989	0.987
Set 2	0.982	0.976	1	0.987	0.965	0.985	0.963	0.951	0.996	0.980	0.983	0.985	0.975	0.971	0.992
Set 3	0.997	0.991	0.987	1	0.990	0.993	0.991	0.982	0.989	0.993	0.995	0.995	0.994	0.993	0.996
Set 4	0.990	0.986	0.965	0.990	1	0.987	0.995	0.995	0.968	0.981	0.990	0.987	0.994	0.996	0.986
Set 5	0.988	0.979	0.985	0.993	0.987	1	0.983	0.975	0.985	0.979	0.991	0.995	0.993	0.990	0.996
Set 6	0.994	0.988	0.963	0.991	0.995	0.983	1	0.994	0.970	0.989	0.986	0.986	0.993	0.994	0.985
Set 7	0.987	0.987	0.951	0.982	0.995	0.975	0.994	1	0.958	0.979	0.981	0.977	0.985	0.992	0.976
Set 8	0.986	0.983	0.996	0.989	0.968	0.985	0.970	0.958	1	0.986	0.984	0.989	0.977	0.977	0.993
Set 9	0.996	0.994	0.980	0.993	0.981	0.979	0.989	0.979	0.986	1	0.985	0.987	0.986	0.984	0.988
Set 10	0.992	0.987	0.983	0.995	0.990	0.991	0.986	0.981	0.984	0.985	1	0.992	0.993	0.994	0.992
Set 11	0.991	0.986	0.985	0.995	0.987	0.995	0.986	0.977	0.989	0.987	0.992	1	0.994	0.992	0.995
Set 12	0.992	0.983	0.975	0.994	0.994	0.993	0.993	0.985	0.977	0.986	0.993	0.994	1	0.995	0.992
Set 13	0.992	0.989	0.971	0.993	0.996	0.990	0.994	0.992	0.977	0.984	0.994	0.992	0.995	1	0.989
Set 14	0.993	0.987	0.992	0.996	0.986	0.996	0.985	0.976	0.993	0.988	0.992	0.995	0.992	0.989	1

Table 7 shows that the Spearman's rank correlation coefficients of the sets have a very high correlation degree ($r_s \geq 0.95$). These results show that changes in the criterion weighting coefficients have no significant effect on the model. On the other hand, a comparative analysis of the stability of the obtained results using GRA was executed throughout the application of other methods. The proposed model was compared to recent techniques such as CRADIS (Compromise Ranking of Alternatives from Distance to Ideal Solution) (Puška et al., 2021), MAIRCA (Multi-Attributive Ideal-Real Comparative Analysis) (Pamučar et al., 2014; 2017). REF-I (Nearest Solution to References-I) (Aytekin and Durucasu, 2021), REF-II (Aytekin, 2021b), WASPAS (Weighted Aggregated Sum Product Assessment) (Zavadskas et al., 2012), PSI (Preference Selection Index) (Maniya and Bhatt, 2010), MABAC (Multi-Attributive Border Approximation Area Comparison) (Pamučar and Ćirović, 2015). The t-score conversion (Aytekin, 2022) was determined for those affected by negative values, λ=0.5 in WASPAS, and reference values in REF-I and REF-II were determined depending on the optimization aspect of the criteria in the applications performed with these methods. Figure 2 depicts the obtained results in the form of a ray graph.

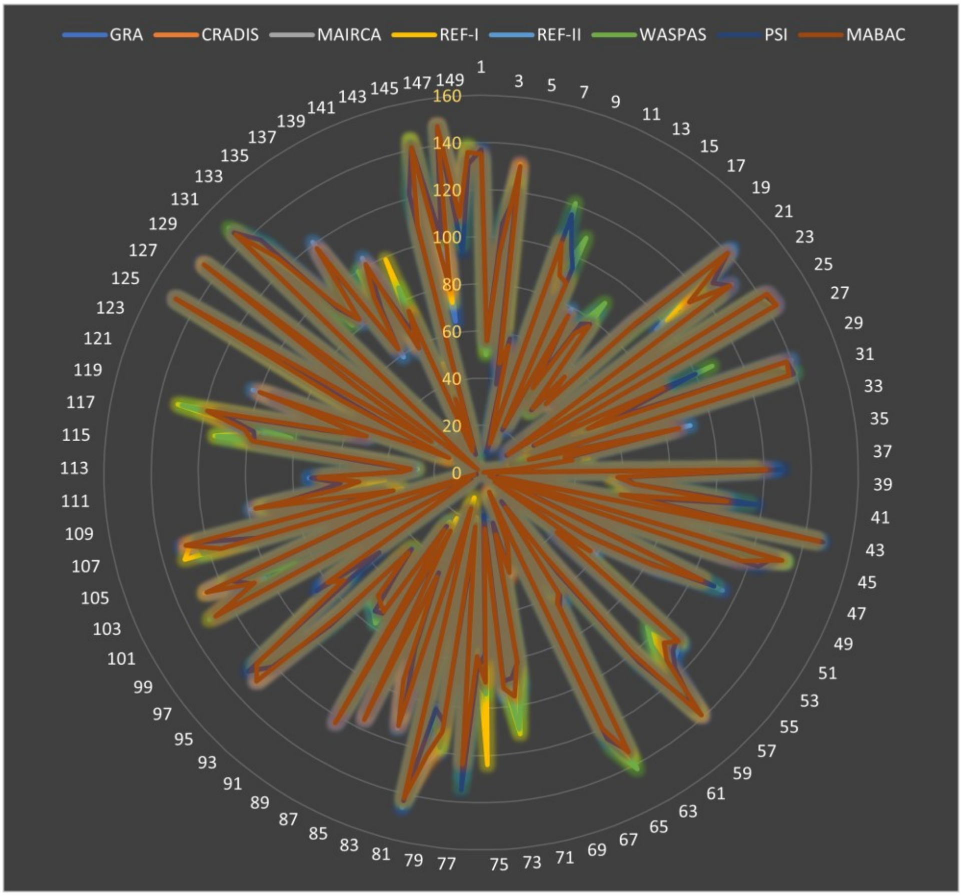

Figure 2 Comparative analysis of ranking results using different methods and GRA

Figure 2 shows the reliability of the GRA rankings. As shown in Figure 2, all methods produced remarkably similar results. The rank correlation coefficients of the methods also shed light on the ranking's similarity and validity. As a result, the GRA method produces strong rank coefficients when compared to the ranking results of CRADIS (r_s=0.996), MAIRCA (r_s=0.993), REF-I (r_s=0.988), REF-II (r_s=0.986), WASPAS (r_s =0.981), and MABAC (r_s =0.993). GRA ranking results are valid and reliable for the nature of the problem determined.

5. Conclusions

The subject of sustainable development and sustainable governance has universal characteristics in that it contains SDGs and sustainable governance indexes that apply to a wide range of disciplines. This study, which considers variables connected to governance, has investigated the effect of sustainable governance on sustainable development. The link between sustainable governance and sustainable development in a sample of 149 countries was discovered. In this context, we have determined that, despite some variances, sustainable governance has an impact on sustainable development. The study's most notable feature is that it uses multiple regression analysis to find the sustainable governance variables that influence sustainable development. In addition, the BWM-GRA multi-criteria decision model is used to classify and evaluate the countries included in the study based on their performance. As a result, by combining two quantitative analytic methods, this study is able to draw a thorough conclusion regarding the research topic. Also, it was limited by considering the criteria/variables, datasets, and countries, and studies relating to this issue were used to determine the variables. In addition, the data diversity has been extended by incorporating data sets from a variety of international agencies and organizations concerned with sustainable governance.

Multiple regression analysis was utilized in this study to investigate the change and relationship between sustainable governance and sustainable development, and four models were estimated. Significant findings were obtained as a result of the established models. It has been established that there is a link between several variable groups and sustainable development and governance. According to the results obtained in the study, variables like the number of people utilizing the internet in a country, the E-Government Index, HDI, the population growth, the rule of law with political transformations, and governance influence sustainable development. The findings are consistent with previous research (Stojanović et al., 2016; Davis, 2017; Güney, 2017; Omri & Ben Mabrouk, 2020). In addition, we also observed that the population growth rate is the strong control variable in analyzing the relationship between sustainable governance and sustainable development indicators. In conclusion, there is an inverse relationship between population increase and sustainable development. This outcome is consistent with the characteristics of the sustainable development paradigm.

On the one hand, components of good governance such as democracy, rule of law, and accountability have a favorable impact on the implementation of sustainability policies. Political polarization and unilateral policies that are not inclusive, on the other hand, have a detrimental impact on sustainability. There is a similarity between the development level indicators of many international agencies and organizations and the GRA results acquired in the study in terms of sustainable development and governance. According to the MCDM findings, countries at the forefront, such as Sweden, Denmark, Norway, and Finland, are also ahead in terms of sustainable development and governance policies. The GRA results obtained for the countries in the study also confirm the literature in this regard.

Sustainable development is also on the rise in some developed and developing countries with average or above-average sustainable governance. The situation in low-income or undeveloped countries where governance quality is below average has a detrimental impact on development sustainability. We confirm that governance has a good and significant impact on SDGs, indicating that this idea will continue to play a unifying and auxiliary role today and in the future. As a matter of fact, reports from international institutions and extraordinary events like the present COVID-19 epidemic demonstrate that systems based on governance, coordination, and cooperation among stakeholders have regained prominence. By properly implementing the rule of law, an independent judiciary, democracy, and related governance features, rules, and regulations, countries can help ensure that present resource use is at a level that is least damaging to future resource use. Additionally, the impact of ICT-related advancements such as the Internet continues to have an impact on governance and development sustainability. Therefore, we suggest that when developing methods to address global concerns, the above-mentioned variables be considered. We believe that it is important to explore the sustainability relationship between governance and development from the perspective of management science and to determine which variables differ from developed and developing countries. In this regard, we suggest a deeper investigation into the nature of the connection between development and governance, ideally by regions and cities. The diverse sets of indicators that can measure the relationship between governance and development can be used to produce unique conclusions and analyses.

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