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Financial Market Sophistication and Global Innovation Ranking Among Upper-Middle-Income Countries[1]

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Üst-Orta Gelir Grubundaki Ülkeler Arasında Finansal Piyasa Gelişmişliği ve Küresel İnovasyon Sıralaması[2]

Abstract

The study's primary purpose is to create a list of innovation rankings for 21 “upper-middle-income” countries based on their performance from 2011 to 2021. Moreover, this paper aims to determine which criteria affect innovation performance more and vice versa. BWM+SD and CoCoSo methods, which are multi-criteria decision-making methods, were used to compare the innovation performances of these countries based on WIPO’s criteria and data. According to the BWM and SD methods, “Knowledge and technology outputs” and “Market sophistication” are the most crucial criteria that affect innovation performance. According to the CoCoSo method, the countries with the highest and the lowest innovation performance are China and Algeria, respectively. The integration of different techniques and the investigation of many countries over a long period represent the uniqueness of this study.

Keywords : Financial Development, Economic Development, Sustainability, Global Innovation Index, Financial Performance.

JEL Classification Codes : G21, O11, O31.

Öz

Çalışmanın öncelikli amacı, “üst-orta gelirli” 21 ülkenin 2011-2021 döneminde sergiledikleri inovasyon performanslarını dikkate alarak, bir başarı listesi oluşturabilmektir. Ayrıca, seçilen kriterlerden hangilerinin inovasyon performansını daha çok, hangilerinin daha az etkilediklerini saptamak amaçlanmıştır. Çok kriterli karar verme yöntemlerinden BWM+SD ve CoCoSo yöntemleri kullanılarak bu ülkelerin WIPO’nun kriterleri ve raporundaki veriler doğrultusunda performansları kıyaslanmıştır. BWM ve SD yöntemlerine göre inovasyon performansını en çok etkileyen kriterler “bilgi ve teknoloji çıktıları” ve “piyasa gelişmişliği” olmuştur. CoCoSo performans sıralama yaklaşımına göre ise inovasyon performansı en yüksek ve en düşük ülkeler sırasıyla Çin ve Cezayir’ dir. Farklı metotların entegre edilmesi ve birçok ülkenin uzun bir zaman diliminde incelenmesi bu çalışmanın emsalsiz olduğunu göstermektedir.

Anahtar Sözcükler : Finansal Kalkınma, Ekonomik Kalkınma, Sürdürülebilirlik, Küresel İnovasyon Endeksi, Finansal Performans.

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1. Introduction

Innovation is not only one of the major locomotives of economies but also a locomotive for the sustainable activities of countries. This is because it increases economic and technological growth, wages, production capacity (Aytekin et al., 2020; Satı, 2024), and international competitiveness of countries (Stojanović et al., 2022). Innovation also increases individuals' living standards by providing significant household technologies (Paredes-Frigolett et al., 2021). Although it allows for social and economic benefits for countries, some countries still face some issues with taking required actions that make them compete with high-income countries or to be in this income group. This might stem from countries' different political, economic, and legal systems.

These factors, namely, economic, legal, and political systems, are based on Institutional Theory and determine innovation activities in a specific region (Trinugroho et al., 2021; Dwivedi & Pawsey, 2023). This is because, depending on their economic, political and legal systems, governments can create different rules and regulations to reduce the costs and risks of applying innovation activities and investments (Tran et al., 2022). Countries with a strong institutional environment can also reduce corruption issues that cause lower protection of intellectual property rights (Jin et al., 2023). Moreover, regulatory and bureaucratic barriers, overregulation and unclear legal frameworks for intellectual property rights create innovation obstacles (Medhioub & Boujelbene, 2025).

Some countries in the G-20, such as Türkiye, China, and Russia, are included under the upper-middle-income countries category. Although these countries are categorised as higher-income groups and some of the world's biggest economies, their R&D expenditures are low. According to the World Bank (2021), the research and development expenditure to % of GDP ratio of Russia, Türkiye, and China are 0,94, 1,40 and 2,43, respectively, where the world average is 2,49. Therefore, these countries need to make more investments in their R&D activities. Like these countries, other countries in the upper-middle income level need to take more innovative actions to hit their targets, namely, being one of the highest-income countries. This is the main argument why this paper focuses on those countries and aims to analyse their innovation performance. Moreover, since the analysed countries are located in different continents, such as Europe, Asia, and Africa, having such a research sample might represent how comprehensive this paper is.

According to the World Bank (2021), countries can be classified by income level as low-income, lower-middle-income, upper-middle-income, and high-income countries. While countries with a GNI per capita lower than 1.045 USD are categorised as low-income countries, the GNI per capita of lower-middle-income, upper-middle-income, and high-income countries differ between 1.046 and 4.095 USD, 4.096 to 12.695 USD, and 12.696 USD and more, respectively (World Bank, 2021).

Countries that allocate more resources for their R&D activities can help businesses create value-added products that increase their GDP and develop new technologies that enable businesses to use their resources for more sustainable purposes. Nobody can ignore the issue of sustainability in today's world. This is why many organisations, such as the United Nations, try to find solutions for this issue by creating 17 sustainable development goals (UNSDGs) for the member states to achieve. In this regard, ministries of governments and other governmental and non-governmental organisations take many actions to hit these sustainable development targets.

Since sustainability is a hot topic and innovation stimulates sustainability practices, countries need to put more emphasis on innovation activities. In this regard, creating a ranking based on the innovativeness of countries is a substantial factor since such a ranking also indicates differences between upper-middle-income countries' financial development. This is because the Global Innovation Index (GII), which this paper considers for analysis purposes, is also based on some economic indicators, such as Market Sophistication. This fact can also draw prospective investors' attention to make more investments in financially developed and better innovation-performing countries, and they might also make innovation investments for countries indicating higher innovation performance.

For these reasons, this study aims to generate innovation performance rankings for 21 upper-middle-income countries by applying integrated BWM+SD and COCOSO methods, some of the Multi-criteria Decision-making (MCDM) methods. To achieve this goal, this study uses the scores of these countries from the GII between 2011 and 2021. Concerning the generation of ranking, this paper analyses the performance factors that WIPO creates when measuring the innovation scores of countries. The research questions are as follows: "What are the innovation scores of 21 upper-middle income countries in the selected period? ", "What are the factors that determine GII and Which factors are more effective when determining GII?", "What are the success rankings of 21 upper-middle-income countries that this paper measures and how these rankings differ from the rankings of WIPO's GII?".

Performance analyses that aim to create rankings have become very popular among MCDM methods. These analyses have been performed in various industries and topics to find the best alternative options. When it comes to the country rankings and the comparison of countries, these methods have also been applied by various researchers to determine countries' rankings for different outcomes (Ayçin & Çakın, 2019; Oralhan & Büyüktürk, 2019; Kabadurmus & Kabadurmus, 2019; Silva et al., 2020a; Silva et al., 2020b; Bakır & Çakır, 2021; Stojanović et al., 2022; Aytekin et al., 2022; Tunsi & Alidrisi, 2023; Satı, 2024). However, these studies have applied various MCDM methods including DEA-EATWIOS (Aytekin et al., 2022), TOPSIS (Kabadurmus & Kabadurmus, 2019; Satı, 2024), CRITIC and CRADIS (Stojanović et al., 2022), CRITIC, EVAMIX and Borda Count (Bakır & Çakır, 2021), Entropy and MABAC (Ayçin & Çakın, 2019), TOPSIS, VIKOR and MOORA (Oralhan & Büyüktürk, 2019), Topsis and PROMETHÉE (Silva et al., 2020a), MCDA and PROMÉTHÉE (Silva et al., 2020b), PROMETHEE II (Tunsi & Alidrisi, 2023). Different from these studies, this paper combines objective (BWM) and subjective (SD) methods in a single paper to reduce the error margin. Moreover, this study is the only one that uses the integrated BWM+SD+CoCoSo method when ranking the innovative performance of different countries. The researchers have also conducted the sensitivity analyses to ensure the reliability and validity of the results. In this regard, the integration of various methods and the existence of sensitivity analyses in this paper might draw the attention of academicians interested in applying these methods when working on the country-level comparisons based on GII.

Moreover, while some of the studies that are mentioned above focus on specific regions such as European Union members and candidates (Oralhan & Büyüktürk, 2019; Silva et al., 2020a; Aytekin et al., 2022; Satı, 2024), Balkan countries (Stojanović et al., 2022), Eastern European and Central Asian (EECA) countries (Kabadurmus & Kabadurmus, 2019), and G8 countries (Tunsi & Alidrisi, 2023), this study analyses upper-middle-income countries that are located in different parts of the world including, Europe, Asia and Africa.

Furthermore, although some researchers examine upper-middle-income countries' innovation rankings, they focus on rankings for limited years (Silva et al., 2020b). Similar to the study of Silva et al. (2020b), some other studies also focus on a minimal number of years in their analyses (Oralhan & Büyüktürk, 2019; Silva et al., 2020a; Stojanović et al., 2022; Tunsi & Alidrisi, 2023). This paper analyses the rankings and other values from GII between 2011 and 2021. Since this paper considers various countries from different parts of the world and includes data from a more extended period, the results of this paper become more comprehensive than those of the others. For this reason, this paper might also draw the attention of policymakers, government officials, and other prospective readers.

2. Literature Review

Due to fierce competition between countries, rapid movements in globalisation, and sustainability trends, countries need to allocate more budgets for their research and development activities. R&D investments positively impact innovation (Leung & Sharma, 2021), a vital process for countries' greater financial and economic development. Innovation includes generating new products, services, systems and procedures (Aytekin et al., 2020). It also stimulates productivity and business capacities (Stojanović et al., 2022). The revenues and productivity of firms can also be stimulated by their innovation activities (Brown et al., 2022) that increase their financial performance (Le & Ikram, 2022), as well as the economic development of countries. For this reason, the sustainability of production facilities and operations is essential for countries' economic power (Lopes et al., 2016).

Many factors affect the innovativeness of countries and their rankings. In this regard, WIPO creates a framework. WIPO is an institution that the United Nations fund. This institution was established in 1967 to promote the protection of intellectual properties and stimulate innovation studies (Silva et al., 2020b). This institution creates the GII that measures innovation competitiveness and performance of countries (Huarng & Yu, 2022). Therefore, this index can also be used by policymakers to improve the innovation performance of their countries (Aytekin et al., 2022).

According to WIPO's GII Report (2023), the overall GII score is the average of Innovation Input and Output Sub-Indexes. While, Innovation Input Sub-Index includes five factors, namely, "Institutions (Institutional, Regulatory and Business Environments)", "Human Capital and Research (Education, Tertiary Education, Research and Development)", "Infrastructure (Information and communication technologies, General Infrastructure, Ecological Sustainability)", "Market Sophistication (Credit, Investments, Trade-Diversification-Market scale)" and "Business sophistication (Knowledge Workers, Innovation Linkages, Knowledge Absorption)", Innovation Output Sub-Index consists of two indicators, namely, "Knowledge and Technology Outputs (Knowledge Creation, Knowledge Impact, Knowledge Diffusion)", and "Creative Outputs (Intangible Assets, Creative Goods and Services, Online creativity)". The Innovation Input Sub-Index represents the factors related to the economy that affect innovative activities. Moreover, Innovation Output-Sub-Index represents the outcomes of economic innovation activities (WIPO's GII Report, 2023). This research will consider all seven criteria for analysis purposes.

As presented above, crucial pillars signal countries' financial development and ecological sustainability. For instance, the Market Sophistication pillar considers some indicators that show financial development of countries, such as Finance for startups and scaleups, Domestic credit to private sector % GDP, Loans from microfinance institutions % GDP, and venture capital investments. Moreover, the ecological sustainability pillar deals with GDP/unit of energy use, Environmental performance, and ISO 14001 environment/bn PPP$ GDP indicators that represent sustainable practices of countries (WIPO's GII Report, 2023). The role that ISO certifications play in the fulfilment of Sustainable Development Goals of the United Nations (UNSDGs) has also been highlighted by some researchers (Toha et al. 2020).

On the other hand, one of the determinants of the Innovation Output Sub-Index, namely, Knowledge and Technology Outputs, is also very substantial for sustainability activities. This is because the Knowledge and Technology Outputs pillar includes some indicators such as the number of patents and model applications, scientific and technical articles, citations of the articles, software spending, high-tech manufacturing, high-tech export, ICT exports and ISO certifications quality (WIPO's GII Report, 2023). Several researchers have used patent applications when measuring innovativeness (Block et al., 2023).

For these reasons, countries with higher rankings from GII can more effectively use their resources. They might indicate greater financial and technological developments and sustainable performance than countries with lower rankings from this index. Higher-ranked countries are also more likely to fulfil the UNSDGs. For instance, counties with higher rankings can provide more credits for businesses that can implement more innovative strategies to create new products and services that satisfy the needs of their customers. By doing so, these firms can increase their revenues, pay more taxes and increase their sales. Their higher productivity can also make them hire more workers. All these actions help businesses reduce the concerns of their primary stakeholders, namely, customers, workers, governments, and shareholders, and they can fulfil their economic and social responsibilities. Thus, countries with such firms can also fulfil Decent Innovation, Industry and Infrastructure, Work and Economic Growth, No Poverty and Reduced Inequalities, the four sustainable development goals of the United Nations (United Nations, 2024).

Many studies also consider GII when measuring the innovation rankings of countries (Silva et al., 2020a; Silva et al., 2020b; Stojanović et al., 2022). For instance, Aytekin et al. (2022) analyse global innovation efficiency of EU member and candidate countries by applying a multi-criteria decision-making method, namely, DEA-EATWIOS. The authors confirm that while the Netherlands, Germany, and Sweden indicate better performance regarding global innovation efficiency, Lithuania, Greece, and North Macedonia have the lowest rankings. Like Aytekin et al. (2022), Satı (2024) compares the digital innovation performance of the EU member and candidate countries by considering GII and applying the entropy weight-TOPSIS method. However, the results of Satı (2024) differ from the findings of Aytekin et al. (2022) since the author substantiates the most significant rankings of Austria, Denmark and Germany and the lowest rankings of Türkiye, Serbia and Croatia from digital innovation performance. By comparing innovation performance of European countries, Ayçin and Çakın (2019) verify the highest performance of Switzerland, Sweden and Denmark, and the lowest performance of Ukraine, Romania and North Macedonia. Moreover, Stojanović et al. (2022) observe Balkan countries' GII between 2019 and 2021, and vindicate the best rankings of Montenegro and Serbia and the worst ranking of Albania. Bakır and Çakır (2021) assess innovation performance of EU and OECD member countries using CRITIC, EVAMIX and Borda methods. Sweden has the first ranking for the GII index, and Hungary has the lowest ranking in this indicator. Kabadurmus and Kabadurmus (2019) evaluate innovation performance of some European and Eastern Asian countries by focusing on various indicators from the BEEPS survey, such as New Product Innovation, New Organisation Innovation, New Marketing Innovation, and New Process Innovation. While the highest and lowest ranked EU member countries are Greece and Latvia, respectively, the results in non-EU member states are Kosovo and Azerbaijan.

On the other hand, Silva et al. (2020b) find different GII rankings for upper-middle-income countries by implementing Borda and PROMETHEE, MCDM methods. The researchers state that while Malaysia ranks first in both methods, Algeria and Ecuador have the lowest rankings from the PROMETHEE and Borda methods. Similarly, Oralhan and Büyüktürk (2019) compare innovation performance of European countries, including Türkiye, and find different results from TOPSIS and MOORA methods. Although the top three countries are the same in the results of both methods (Switzerland, Sweden and Denmark), the countries having the lowest rankings are Ukraine, Romania and Macedonia in the TOPSIS method, while this result is different in the MOORA method, indicating Romania, Ukraine and Poland as the last three countries. Silva et al. (2020a) also compare the rankings of countries from GII and their results from TOPSIS and Promethee MCDM methods, while their results do not differ regarding the best (Switzerland) and the worst-ranked countries (Albania), other countries' rankings show differences depending on the findings from MCDM methods. Stojanović et al. (2022) measure the rankings of G8 countries regarding the Innovation-Based Human Development Index and apply the PROMETHEE II, MCDM method; their results from the MCDM method differ from the original rankings that the countries have from the Innovation-Based Human Development Index. To sum up, the creation of rankings by MCDM methods can vary from the original rankings received from various indexes, as some studies have confirmed (Oralhan & Büyüktürk, 2019; Silva et al., 2020a; Tunsi & Alidrisi, 2023). Thus, this paper might expect various innovation ranking results created by integrated BWM+SD+CoCoSo MCDM methods than the original ranking of GII.

3. Methodology

This study applies some MCDM methods to hit the research target. As presented above, many MCDM methods exist, and they help users find practical solutions for decision-making problems. These methods assess various and complicated criteria together to select the best options among different alternatives. For these reasons, MCDM methods rationally minimise decision-making and selection of criteria issues (Arslan, 2018).

This paper integrates some MCDM criterion weighting methods, such as BWM (Best and Worst Method) and SD (Standard Deviation), together with CoCoSo (Combined Compromise Solution) financial performance ranking, for analysis purposes. Research data is gained from the World Intellectual Property Organisation (WIPO)'s 2023 report, "Global Innovation Index 2023: Innovation in the face of uncertainty."

3.1. BWM Method

Best Worst Method (BWM) states that decision-makers decide the most important and least critical criteria. Each of the best and worst criteria is compared to the other criteria. The aim is to explore the consistency of optimal weights and matrices with a simple optimisation model created using the comparison system. The exact steps of the BWM method that other studies use are followed by this paper as well (Rezaei, 2015; Rezaei, 2016; Şimşek et al., 2023):

Step 1: Determination of evaluation criteria.

Step 2: Determining the best and worst criteria to solve the decision problem.

Step 3: Determining the preference of the best criterion according to all other criteria.

Step 4: Determination of the preference of all other criteria according to the worst criterion.

Step 5: Determination of the optimal weights of the criteria.

3.2. SD Method

This method objectively determines the weight and significance of the decision-making criteria. Diakoulaki et al. (1995) were the first researchers to apply this method. This method is based on the degree of contrast between criteria. The standard deviation of each criterion is considered when objectively measuring the significance of all requirements. The steps of the measurement are summarised by various researchers (Diakoulaki et al., 1995; Kılıç & Çerçioğlu, 2016; Bağcı & Yiğiter, 2019). The steps are presented as follows:

Step 1. Generating a decision matrix indicates several alternatives' performance based on various characteristics.

Step 2specificlisation of the decision matrix.

Step 3. The standard deviation of each criterion is calculated using the following formula.

$$\sigma j = \sqrt{\frac{\sum_{i=1}^{m}(nij - \bar{n}ij)2}{m}} \quad j = 1,2, \dots n \tag{1}$$

Step 4. The weights of the criteria are calculated by the formula that is presented as follows:

$$\mathrm{Wj} = \frac{\sigma j}{\sum_{j=1}^{n}\sigma j} \quad j = 1,2,3, \dots, n \tag{2}$$

3.3. CoCoSo Method

CoCoSo (Combined Compromise Solution) is a ranking method first applied by Yazdani et al. (2019). The method includes five steps that are presented as follows: (Akbulut & Hepşen, 2021; Akgül, 2021; Deveci et al., 2021; Ecer & Pacamur, 2020; Özdağoğlu et al., 2020; Ulutaş et al., 2020; Yazdani et al., 2019).

Step 1: The generation of the initial decision matrix.

Step 2: The creation of a normalised (standard) decision matrix.

Step 3: The weighted comparability sequence for an alternative is created by the following formula:

$$\mathrm{S_i} = \sum_{j=1}^{n}(\mathrm{r_{ij}}\; x\; w_{\mathrm{j}}) \tag{3}$$

S represents the alternative of i’s weighted comparability sequence, while w_j indicates the weight of the j criterion.

Step 4: The amount of the exponential weight of comparability sequences for each alternative (P_i) is measured by the 4th formula.

most significant$P_i = \sum_{j=1}^{n}(r_{ij})\, w_j$ (4)

1. k_{ia}: a aggregation strategy for the alternative of i. $k_{ia}=\frac{Pi+Si}{\sum_{j=1}^{m}(Pi+Si)}$ (5)

2. k_{ib}: b aggregation strategy for the alternative of i. $k_{ib}=\frac{Sj}{\min Si}+\frac{Pj}{\min Pi}$ (6)

3.k_{ic}: c aggregation strategy for alternative of i. $ic=\frac{\lambda Si+(1-\lambda)Pi}{\lambda\, maxi\, Si+(1-\lambda)maxi\, Pi}$ (7)

λ: balance value. λ value differs between 0 and 1, while decision makers usually select 0.5.

Step 5: The calculation of k_i for the final ranking of the alternatives

k_i=3$\sqrt{kiakibkic}$+ $\frac{kia+kib+kic}{3}$ (8)

A greater value that k_i has is considered the best alternative (as more significant than better).

4. Results

4.1. Main Results

As mentioned above, this study investigates 21 upper-middle-income countries' innovation scores from GII from 2011 to 2021. The countries are Albania, Algeria, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, China, Georgia, Iran, Jordan, Kazakhstan, Lebanon, the Republic of Moldova, Montenegro, Romania, the Russian Federation, Serbia, North Macedonia, Tunisia, and Türkiye.

WIPO has adopted seven criteria to determine the innovation scores of the countries. These are “Institutions”, “Human capital and research”, “Infrastructure”, “Market sophistication”, “Business sophistication”, “Knowledge and technology outputs” and “Creative outputs”. Table 1 indicates the average GII scores of the selected countries. The data that this paper analyses is taken from the WIPO's 2023 GII Report, namely, “Innovation in the face of uncertainty”.

Table: 1
GII Scores of High-Middle-Income Countries (2011-2021)

	Criterions	Institutions	Human Capital and Research	Infrastructure	Market Sophistication	Business Sophistication	Knowledge and Technology Outputs	Creative Outputs
	Criterion Codes	**c1**	**c2**	**c3**	**c4**	**c5**	**c6**	**c7**
Country Codes	**Countries**							
A1	Albania	62,3	24,1	39,1	52,2	23,6	15,5	22,4
A2	Algeria	45,4	28,6	31,5	33,6	22,5	16,1	13,3
A3	Armenia	62,7	20,8	34,3	46,6	26,4	25,8	30,4
A4	Azerbaijan	57,8	22,1	37,3	53,0	23,2	15,8	25,0
A5	Belarus	53,7	41,5	41,4	44,2	29,1	29,5	18,0
A6	Bosnia and Herzegovina	58,0	37,4	33,0	47,6	32,3	22,2	20,6
A7	Bulgaria	68,9	33,5	45,8	44,8	36,5	33,8	39,1
A8	China	54,9	44,6	49,7	54,7	50,6	56,8	41,2
A9	Georgia	70,8	27,3	37,7	52,6	27,0	24,8	26,1
A10	Iran	44,3	37,4	34,7	32,6	24,4	25,1	24,6
A11	Jordan	62,6	28,6	35,5	39,4	23,1	18,9	23,9
A12	Kazakhstan	65,5	30,6	43,3	43,6	27,9	20,0	20,2
A13	Lebanon	53,1	32,5	34,7	41,5	35,1	21,5	28,7
A14	Republic of Moldova	59,1	29,0	37,1	48,6	23,3	26,4	29,2
A15	Montenegro	67,8	37,7	42,3	48,0	32,2	22,0	38,8
A16	Romania	67,5	30,9	45,5	42,8	32,2	33,5	30,9
A17	Russian Federation	58,2	47,9	42,0	45,7	38,4	29,8	27,5
A18	Serbia	64,7	34,3	42,8	39,5	30,0	29,4	30,1
A19	North Macedonia	68,7	31,8	37,9	50,5	30,1	24,2	28,7
A20	Tunisia	61,7	37,0	35,5	34,6	26,8	21,8	35,5
A21	Türkiye	54,9	36,4	41,1	47,5	28,5	26,4	37,8

Source: WIPO (2023). GII, 2023, Innovation in the face of uncertainty.

Two different MCDM methods, BWM and SD, are integrated to analyse countries' innovation performance by considering the weightings of criteria determined by WIPO institutions. Table 2 depicts seven criteria and their weights to measure innovation performance. Greater scores in all criteria presented in Table 2 indicate a higher effect on the innovation performance scores of a specific criterion.

Table: 2
Criteria and Weights (BWM+SD)

Name	Code	BWM	SD	AVG
Institutions	**c1**	0,069	0,152	0,110
Human capital and research	**c2**	0,083	0,144	0,113
Infrastructure	**c3**	0,038	0,098	0,068
Market sophistication	**c4**	0,207	0,132	0,169
Business sophistication	**c5**	0,138	0,138	0,138
Knowledge and technology outputs	**c6**	0,361	0,184	0,272
Creative outputs	**c7**	0,104	0,153	0,128

Table 2 also indicates the weights of the criteria found by both methods, BWM and SD. According to this table, the Knowledge and Technology Outputs criteria have the most significant weight compared to other criteria, and the results of both methods confirm this fact. Although an objective and a subjective method have been performed, the results are consistent. However, the Knowledge and Technology pillar is more significant in the BWM method than the others. This is because while the weight coefficient for Knowledge and Technology outputs is 36,1% in the BWM method, this indicator for the SD method is

18,4%. The average of both of these volumes is calculated as 27,2%. The second most effective pillar in innovation performance measurement is market sophistication. As mentioned, this indicator is crucial when analysing countries' financial development. This result also represents how financial indicators are vital to measure countries' innovation performance.

After determining the weight of each criterion, this paper performs the CoCoSo method and follows its steps. The results from each step of the CoCoSo method are presented in Table 3 (Step 2), Table 4 (Step 3), Table 5 (Step 4), and Table 6 (Step 5).

Table: 3
Normalized Matrix

Codes	c1	c2	c3	c4	c5	c6	c7
A1	0,678	0,121	0,414	0,889	0,038	0,000	0,327
A2	0,043	0,288	0,000	0,044	0,000	0,015	0,000
A3	0,694	0,000	0,154	0,632	0,140	0,248	0,612
A4	0,510	0,047	0,318	0,924	0,025	0,007	0,418
A5	0,354	0,762	0,544	0,524	0,236	0,338	0,169
A6	0,518	0,614	0,082	0,679	0,350	0,162	0,262
A7	0,931	0,468	0,783	0,550	0,499	0,442	0,925
A8	0,400	0,880	1,000	1,000	1,000	1,000	1,000
A9	1,000	0,240	0,339	0,907	0,161	0,225	0,459
A10	0,000	0,614	0,175	0,000	0,069	0,233	0,405
A11	0,691	0,290	0,220	0,307	0,019	0,081	0,381
A12	0,802	0,361	0,646	0,498	0,190	0,109	0,245
A13	0,331	0,434	0,177	0,401	0,446	0,146	0,551
A14	0,559	0,304	0,307	0,726	0,027	0,264	0,570
A15	0,888	0,625	0,590	0,696	0,345	0,156	0,913
A16	0,877	0,373	0,768	0,459	0,346	0,435	0,630
A17	0,525	1,000	0,573	0,591	0,564	0,345	0,508
A18	0,771	0,497	0,619	0,313	0,267	0,337	0,602
A19	0,923	0,407	0,350	0,810	0,269	0,211	0,551
A20	0,659	0,598	0,219	0,087	0,153	0,152	0,794
A21	0,399	0,575	0,526	0,675	0,213	0,264	0,879

Table: 4
Weighted Comparability Sequence and Si

Codes	c1	c2	c3	c4	c5	c6	c7
A1	0,075	0,014	0,028	0,151	0,005	0,000	0,042
A2	0,005	0,033	0,000	0,007	0,000	0,004	0,000
A3	0,077	0,000	0,011	0,107	0,019	0,068	0,078
A4	0,056	0,005	0,022	0,156	0,003	0,002	0,054
A5	0,039	0,087	0,037	0,089	0,033	0,092	0,022
A6	0,057	0,070	0,006	0,115	0,048	0,044	0,034
A7	0,103	0,053	0,053	0,093	0,069	0,120	0,119
A8	0,044	0,100	0,068	0,169	0,138	0,272	0,128
A9	0,110	0,027	0,023	0,154	0,022	0,061	0,059
A10	0,000	0,070	0,012	0,000	0,009	0,063	0,052
A11	0,076	0,033	0,015	0,052	0,003	0,022	0,049
A12	0,089	0,041	0,044	0,084	0,026	0,030	0,031
A13	0,037	0,049	0,012	0,068	0,062	0,040	0,071
A14	0,062	0,035	0,021	0,123	0,004	0,072	0,073
A15	0,098	0,071	0,040	0,118	0,048	0,042	0,117
A16	0,097	0,042	0,052	0,078	0,048	0,119	0,081
A17	0,058	0,113	0,039	0,100	0,078	0,094	0,065
A18	0,085	0,056	0,042	0,053	0,037	0,092	0,077
A19	0,102	0,046	0,024	0,137	0,037	0,057	0,071
A20	0,073	0,068	0,015	0,015	0,021	0,041	0,102
A21	0,044	0,065	0,036	0,114	0,029	0,072	0,113

Table: 5
Exponentially Weighted Comparability Sequence and Pi

Codes	c1	c2	c3	c4	c5	c6	c7
A1	0,958	0,787	0,942	0,980	0,637	0,000	0,866
A2	0,706	0,868	0,000	0,589	0,000	0,321	0,000
A3	0,960	0,000	0,880	0,925	0,762	0,684	0,939
A4	0,928	0,706	0,925	0,987	0,601	0,254	0,894
A5	0,892	0,970	0,959	0,896	0,819	0,744	0,796
A6	0,930	0,946	0,843	0,936	0,865	0,609	0,842
A7	0,992	0,917	0,983	0,904	0,909	0,801	0,990
A8	0,904	0,986	1,000	1,000	1,000	1,000	1,000
A9	1,000	0,851	0,929	0,984	0,777	0,666	0,905
A10	0,000	0,946	0,888	0,000	0,691	0,673	0,890
A11	0,960	0,869	0,902	0,819	0,580	0,505	0,884
A12	0,976	0,891	0,971	0,889	0,795	0,547	0,835
A13	0,885	0,910	0,888	0,857	0,895	0,592	0,926
A14	0,938	0,874	0,923	0,947	0,607	0,696	0,930
A15	0,987	0,948	0,965	0,940	0,863	0,603	0,988
A16	0,986	0,894	0,982	0,876	0,864	0,797	0,942
A17	0,931	1,000	0,963	0,915	0,924	0,749	0,917
A18	0,972	0,924	0,968	0,821	0,833	0,744	0,937
A19	0,991	0,903	0,931	0,965	0,834	0,654	0,926
A20	0,955	0,943	0,902	0,662	0,772	0,599	0,971
A21	0,904	0,939	0,957	0,936	0,808	0,696	0,984

Table: 6
Final Aggregation and Ranking

Country	Ka	Ranking	Kb	Ranking	Kc	Ranking	K	Final Ranking
A1	0,042	19.000	8,503	17.000	0,702	19.000	3,716	17
A2	0,020	21.000	2,000	21.000	0,324	21.000	1,015	21
A3	0,043	18.000	9,408	14.000	0,706	18.000	4,042	15
A4	0,043	17.000	8,225	18.000	0,716	17.000	3,629	18
A5	0,050	10.000	10,559	10.000	0,829	10.000	4,573	10
A6	0,049	11.000	10,025	12.000	0,813	11.000	4,366	12
A7	0,055	2.000	15,074	2.000	0,910	2.000	6,257	2
A8	0,060	1.000	21,550	1.000	1,000	1.000	8,629	1
A9	0,051	9.000	11,782	8.000	0,841	9.000	5,020	8
A10	0,033	20.000	5,860	20.000	0,550	20.000	2,623	20
A11	0,045	16.000	7,320	19.000	0,739	16.000	3,324	19
A12	0,048	14.000	9,422	13.000	0,800	14.000	4,138	13
A13	0,049	13.000	9,284	15.000	0,805	13.000	4,094	14
A14	0,049	12.000	10,314	11.000	0,807	12.000	4,464	11
A15	0,053	5.000	13,435	4.000	0,874	5.000	5,641	4
A16	0,053	4.000	13,091	5.000	0,878	4.000	5,523	5
A17	0,054	3.000	13,751	3.000	0,889	3.000	5,768	3
A18	0,051	8.000	11,527	9.000	0,850	8.000	4,939	9
A19	0,052	7.000	12,178	6.000	0,855	7.000	5,175	6
A20	0,048	15.000	9,163	16.000	0,786	15.000	4,031	16
A21	0,052	6.000	12,169	7.000	0,857	6.000	5,174	7

While the final Rankings of the countries are presented in Table 6, they are ordered in Table 7. The lower rankings represent the greater innovation performance of countries. While China has the best ranking, Bulgaria and the Russian Federation's rankings are 2 and 3, respectively. Moreover, while Türkiye takes the 7th position in this ranking, Algeria has the worst.

Table: 7
Ranking List

Countries	Codes	Final Ranking
China	A8	1
Bulgaria	A7	2
Russian Federation	A17	3
Montenegro	A15	4
Romania	A16	5
North Macedonia	A19	6
Türkiye	A21	7
Georgia	A9	8
Serbia	A18	9
Belarus	A5	10
Republic of Moldova	A14	11
Bosnia and Herzegovina	A6	12
Kazakhstan	A12	13
Lebanon	A13	14
Armenia	A3	15
Tunisia	A20	16
Albania	A1	17
Azerbaijan	A4	18
Jordan	A11	19
Iran	A10	20
Algeria	A2	21

On the other hand, the rankings that this paper finds by using MCDM methods are compared with the rankings of WIPO in Table 8. As indicated in this table, while the rankings of China, Bulgaria, Romania, and Algeria do not change, some differences exist in the rankings of other countries. However, there is not such a big difference among them.

Table: 8
The Comparison of WIPO's Ranking and This Study's Ranking

Country	Code	Ranking of This Study	Ranking of WIPO
China	A8	1	1
Bulgaria	A7	2	2
Russian Federation	A17	3	4
Montenegro	A15	4	3
Romania	A16	5	5
North Macedonia	A19	6	9
Türkiye	A21	7	7
Georgia	A9	8	11
Serbia	A18	9	8
Belarus	A5	10	13
Republic of Moldova	A14	11	6
Bosnia and Herzegovina	A6	12	16
Kazakhstan	A12	13	17
Lebanon	A13	14	15
Armenia	A3	15	10
Tunisia	A20	16	12
Albania	A1	17	19
Azerbaijan	A4	18	20
Jordan	A11	19	14
Iran	A10	20	18
Algeria	A2	21	21

4.2. Sensitivity Analysis

In the first stage of the Sensitivity Analysis, criterion weights were redetermined according to 20 different scenarios. For this purpose, the weight of the criterion with the highest weight among the original criterion weights (C6 criterion) found according to the arithmetic mean of the BWM and SD weight methods was reduced by 5 percent in each scenario compared to the original weight, while the weights of the other criteria were rearranged as a result of distributing the reduced amount according to the weight. This process continued until the weight of the criterion with the highest weight was reset.

Table: 9
Varying Weights

W_{nb}	set1	set2	set3	set4	set5	set6	set7	set8	set9	set10	set11	set12	set13	set14	set15	set16	set17	set18	set19	set20
c1	0,112	0,115	0,117	0,119	0,121	0,123	0,125	0,127	0,129	0,131	0,133	0,135	0,137	0,139	0,141	0,143	0,146	0,148	0,150	0,152
c2	0,116	0,118	0,120	0,122	0,124	0,126	0,128	0,130	0,133	0,135	0,137	0,139	0,141	0,143	0,145	0,147	0,150	0,152	0,154	0,156
c3	0,070	0,071	0,072	0,073	0,075	0,076	0,077	0,079	0,080	0,081	0,082	0,084	0,085	0,086	0,087	0,089	0,090	0,091	0,093	0,094
c4	0,173	0,176	0,179	0,182	0,185	0,188	0,192	0,195	0,198	0,201	0,204	0,207	0,211	0,214	0,217	0,220	0,223	0,226	0,230	0,233
c5	0,140	0,143	0,146	0,148	0,151	0,153	0,156	0,159	0,161	0,164	0,166	0,169	0,171	0,174	0,177	0,179	0,182	0,184	0,187	0,189
c6	0,259	0,245	0,231	0,218	0,204	0,191	0,177	0,163	0,150	0,136	0,123	0,109	0,095	0,082	0,068	0,054	0,041	0,027	0,014	0,000
c7	0,130	0,133	0,135	0,138	0,140	0,143	0,145	0,147	0,150	0,152	0,155	0,157	0,159	0,162	0,164	0,167	0,169	0,171	0,174	0,176
SUM	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

In Table 10, the sorting process performed by the CoCoSo method is repeated according to the different weight coefficients in 20 scenarios created in Table 9. The original order of the alternatives has hardly changed. Thus, it has been concluded that our weight coefficients are robust and reliable.

Table: 10
Changing Rankings

	Ranking Original	set1	set2	set3	set4	set5	set6	set7	set8	set9	set10	set11	set12	set13	set14	set15	set16	set17	set18	set19	set20
A1	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
A2	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
A3	15	15	16	16	16	16	16	16	16	16	16	16	16	16	16	18	18	18	18	18	18
A4	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	16	16	16	16	16	16
A5	10	10	10	10	10	10	10	10	10	10	11	11	11	12	12	12	12	13	13	13	13
A6	12	12	12	12	12	12	12	12	11	11	10	10	10	10	10	10	10	10	10	10	10
A7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
A8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
A10	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
A11	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
A12	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	11	11
A13	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
A14	11	11	11	11	11	11	11	11	12	12	12	12	12	11	11	11	11	11	11	12	12
A15	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
A16	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7
A17	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
A18	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
A19	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5
A20	16	16	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
A21	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6

In the second stage of the sensitivity analysis, criterion weights were determined by methods that determined other criterion weights. For this purpose, the WENSLO, LOPCOW, ENTROPY, CRITIC, and PSI methods, which are frequently used in the literature, were used. According to these different methods, the correlation coefficient between the resulting and original weight coefficients was calculated and presented in Table 11. The WENSLO and ENTROPY methods reached the highest correlation coefficients.

Table: 11
Different Weight Methods

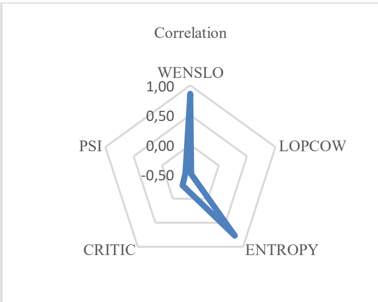
W	(BMW+SD)/2	WENSLO	LOPCOW	ENTROPY	CRITIC	PSI
c1	0,110	0,046	0,189	0,049	0,204	0,177
c2	0,113	0,131	0,154	0,141	0,167	0,130
c3	0,068	0,042	0,139	0,046	0,110	0,184
c4	0,169	0,056	0,169	0,065	0,190	0,164
c5	0,138	0,147	0,082	0,147	0,100	0,148
c6	0,272	0,409	0,090	0,329	0,096	0,115
c7	0,128	0,169	0,177	0,223	0,133	0,081

According to Table 12 and Figure 1, the correlation coefficient between the weight method we used and the results of the WENSLO weight method is 86% and 77%, respectively, related to the results of ENTROPY. On the other hand, there is a small and negative correlation with the results found by the LOPCOW, CRITIC and PSI methods.

Table: 12
Correlation Coefficients

WENSLO	LOPCOW	ENTROPY	CRITIC	PSI
0,86	-0,48	0,77	-0,28	-0,41

Figure: 1
Different Weight Methods



In the third stage of the sensitivity analysis, the results of different ranking methods were obtained using the original criterion weights. For this purpose, AROMAN, TOPSIS, EDAS, ARAS and COPRAS ranking methods, which are widely used in the literature, were applied. The application results are shown in Table 13, Table 14, and Figure 2.

Table: 13
Different Ranking Methods

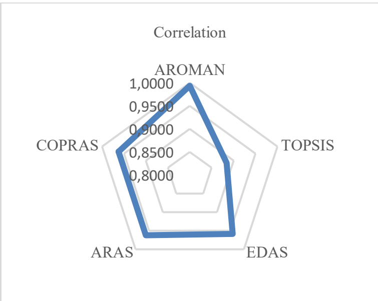
	CoCoSo	AROMAN	TOPSIS	EDAS	ARAS	COPRAS
A1	17	17	19	19	19	19
A2	21	21	21	21	21	21
A3	15	13	11	12	12	12
A4	18	18	18	20	20	20
A5	10	10	7	9	9	9
A6	12	12	15	14	13	13
A7	2	2	2	2	2	2
A8	1	1	1	1	1	1
A9	8	8	12	10	10	10
A10	20	20	14	17	17	17
A11	19	19	20	18	18	18
A12	13	15	17	16	16	16
A13	14	14	16	13	15	15
A14	11	11	9	11	11	11
A15	4	4	8	6	5	5
A16	5	5	3	4	4	4
A17	3	3	4	3	3	3
A18	9	9	5	7	7	7
A19	6	7	10	8	8	8
A20	16	16	13	15	14	14
A21	7	6	6	5	6	6

Table: 14
Correlation Coefficients

AROMAN	TOPSIS	EDAS	ARAS	COPRAS
0,9935	0,8844	0,9584	0,9623	0,9623

According to Table 14, the ranking obtained by the CoCoSo method used in this paper was the highest, compatible with the ranking found by the AROMAN method. The results of the other four methods are also highly compatible. Thus, the results of the sequencing method applied in this research proved robust and reliable.

Figure: 2
Different Ranking Methods



4.3. Discussion

The results of this paper confirm the differences between the rankings that this research observes from the analyses of MCDM methods and the rankings of WIPO. For this reason, the results of this study are compatible with the studies of Silva et al. (2020a), Oralhan and Büyüktürk (2019), and Tunsi and Alidrisi (2023), which also substantiate different rankings than the ranking of WIPO.

On the other hand, one of the results of this paper contradicts the study of Silva et al. (2020b), since these researchers confirm the first ranking of Malaysia among upper-middle income countries, followed by Montenegro, Bulgaria, Romania and China. This paper differs from the study of Silva et al. (2020b) because of the year of ranking. While the study of Silva et al. (2020b) only considers the scores from GII in 2016, this paper focuses on GII scores between 2011 and 2021.

Another crucial result in this paper is the innovation ranking of Türkiye from WIPO. Although Türkiye is the 3rd biggest economy among the investigated countries in this paper (World Bank, 2021), its ranking from GII is 7. Türkiye’s ranking is even lower than some countries, such as Romania and Bulgaria, with a lower R&D expenses-to-GDP ratio (World Bank, R&D expenses-to-GDP ratio, 2021). This result might be related to the membership of Romania and Bulgaria in the EU. Since the EU provides many R&D funds and incentives for innovation activities, including ICT (Information and Communication Technology) projects for member countries, this argument might support why Romania and Bulgaria have better innovation performance than Türkiye and most upper-middle-income countries analysed in this research. Moreover, these European member countries follow the economic, legal and policies of other EU member states. This fact also might have given these countries a more quality institutional structure that stimulates innovation performance.

The quality of institutional structure in these countries might also be the reason for the greater foreign direct investment inflow to GDP ratio of Romania and Bulgaria than that of Türkiye. According to the World Bank (2023), the volumes of Bulgaria and Romania from Foreign Direct Investment (FDI) Net inflows to % of GDP ratio are 4,0 and 2,50, respectively. However, the value for Türkiye from this indicator is just 1,0. FDI inflows gained by these countries include the investments of foreign Information and Communication Technology companies in their markets. In this regard, foreign ICT firms might have made Bulgaria and Romania show greater innovation performance.

Moreover, one of the advantages of FDI inflow is agglomeration. Whenever foreign firms enter new countries and locate their factories in industrial zones, there will be knowledge spillover, and the knowledge will move from foreign companies to local businesses and vice versa. This is because local businesses can hire engineers or technicians from foreign companies, and these workers can play important roles in local businesses' innovation activities and improve their innovation performance. Technology sharing between local and foreign companies might become more likely, which might also be a reason for the greater innovation performance of Romania and Bulgaria compared to Türkiye.

Another important indicator that might represent the greater innovation performance of Romania and Bulgaria than Türkiye is the trade-to-GDP ratio. According to the World Bank, this ratio explains the total exports and imports of goods and services as a share of GDP. The values of Bulgaria, Romania, and Türkiye from this ratio are 120, 83, and 66, respectively (World Bank, 2023). Similar to explanations presented for FDI, it might be stated that those countries' exported and imported products and services might have increased the competitiveness and innovative performance of Bulgarian and Romanian businesses. This is because these firms might have tried to improve the quality of the products that they export. The imported products or services might have also motivated local businesses of these countries to produce more quality goods for import substitution.

Although innovation substantially contributes to countries' economic development by increasing production capacity (Satı, 2024) and international competitiveness (Stojanović et al., 2022), it has some unintended consequences, such as job loss in traditional industries. In this regard, some researchers compare various industries and confirm the fact that while innovation shows job-creating effect and labour-friendly nature in high-tech industries such as Information Communication and Technology (ICT) sector, it does not make positive contributions to the creation of workforce for low-tech sectors (Piva & Vivarelli, 2018; Bogliacino & Vivarelli, 2012), such as traditional industries (Bogliacino et al., 2012; Bogliacino & Pianta, 2010). Similar to the arguments of these studies, Cirillo et al. (2018) also state the negative impact of innovation on job creation in traditional industries such as the service sector.

The differences regarding the impact of innovation on job creation in various industries might be based on the type of innovation activities that various industries perform. According to Lucchese and Pianta (2012), a significant difference exists between product and process innovation activities. While the product innovation enables job creation, the latter includes labour-saving actions that cause job loss (Lucchese & Pianta, 2012). This is because product innovation activities require the workforce to use advanced or more developed technologies, especially in the ICT industry. On the other hand, the labour-saving nature of process innovation activities does not play an employment creation role in service industries that include financial services, tourism, food services, health and education (Harrison et al. 2014).

Since high-tech industries such as ICT create more job opportunities for software and computer engineers and technicians, policy-makers can direct the young generation to select these kinds of job occupations in their career path. Türkiye needs to implement these strategies more than other countries, such as Bulgaria and Romania, since the share of the ICT sector on GDP in these countries was 7,47% and 4,47%, respectively (Statista, 2024). Moreover, the values of Bulgaria and Romania from this indicator were 9,6% and around 4 to 5%, respectively, in 2023 (ReportLinker, 2023), while Türkiye's volume was just 2,5% (TÜİK, 2023). In this regard, policy-makers in Türkiye might provide more financial support and credit opportunities for ICT firms to stimulate their contribution to the country's GDP volume. Since the ICT sector also generates labour-friendly innovation activities, more job opportunities can be provided to software, computer, mechanical, electrical, and electronics engineers and technicians. Individuals who have lost their jobs in traditional industries might be trained to become technicians. By doing so, the job losses in traditional industries might be compensated for by new job opportunities presented by high-tech industries such as ICT. The quality of education in vocational high schools and vocational schools of higher education can be increased to motivate students to become well-educated engineers and technicians. Although students can work as interns, the period of internship activities needs to be longer to make students more experienced.

Regarding other upper-middle-income countries, it is important to consider the size of the economy. This is because a positive relationship exists between the size of the economy and innovation (Majerova, 2015). However, this fact has not been confirmed by the rankings of WIPO or this paper. Although some countries, such as Iran, Kazakhstan, Azerbaijan, and Algeria, have greater GDP volumes (World Bank, 2021) than most countries in the upper-middle income category, their ranks in the list of countries are lower than most other countries.

5. Conclusion

Upper-middle-income countries, including Türkiye, China, and Russia, need to focus on innovation activities and invest more to be considered high-income countries. However, they also need to implement some measures for their financial development (Market Sophistication) since it is also a determining factor of their innovation performance.

This is because innovation not only includes technological innovation, but also includes inventions to develop financial markets and infrastructure, to ease business life, and to increase human capital. Therefore, it is a comprehensive process comprising various developments and inventions. For these reasons, countries taking more innovative initiatives can improve their economic conditions and provide more social benefits. In this regard, determining innovation performance ranking is crucial to indicate country differences and provide some opportunities for countries with lower income levels. This paper analyses innovation performance rankings for countries categorised under the upper-middle income level. This paper gains data from the GII, which the WIPO institution creates to hit this target. This paper considers the scores of countries between 2011 and 2021. All criteria that WIPO includes to determine countries' innovation performance are also included in this paper. These are "Institutions", "Human capital and research", "Infrastructure", "Market sophistication", "Business sophistication", "Knowledge and technology outputs" and "Creative outputs".

This paper uses various Multi-criteria Decision-making (MCDM) methods, namely, BWM+SD and CoCoSo methods, for analysis purposes. While BWM and SD methods are integrated to find the most influential factors determining innovation performance, the CoCoSo method is used for the performance rankings of the countries. The sensitivity analyses have also confirmed the results' validity and reliability. The results from the BWM and SD methods show that Knowledge and technology outputs and Market sophistication pillars are the most influential factors that affect the countries' innovation performance. Moreover, the findings from the CoCoSo method indicate that while China and Bulgaria have the most significant innovation performance rankings, Algeria has the lowest. Furthermore, the rankings this paper finds show similarities with the rankings of the WIPO organisation, since some countries' rankings are the same in both evaluations. On the other hand, the ranking of Türkiye from both WIPO's and this study's rankings is the same, seven.

Since Türkiye has a lower ranking than other countries with lower GDP levels, and R&D investments such as Bulgaria and Romania, policymakers need to implement more effective strategies to stimulate innovation activities in this country. In this regard, since the following pillars that this paper finds carry high importance for innovation performance, namely, Knowledge and Technology Outputs and Market Sophistication, Türkiye can focus more on the determinant factors of these pillars. Therefore, domestic credit to the private sector and loans for startups and microenterprises can be increased for innovation activities. Moreover, policymakers can stimulate the number of patents, models, ISO quality applications, and scientific and technical articles and increase software spending. In addition to doing that, high-tech manufacturing, high-tech export, and ICT exports by companies can be motivated by governments.

Furthermore, the European Union provides financial support to stimulate sustainable innovation activities that meet the sustainability targets of the UN. For instance, many funding programs such as Horizon Europe, ITER and Euratom Research and Training Programme, European Agricultural Guarantee Fund (EAGF), and Programme for the Environment and Climate Action (LIFE) are represented by the EU to prospective applicants. Those supports of the EU might be the reason for Bulgaria and Romania's higher rankings. In this regard, the Turkish government can also draw the attention of companies, universities, and other organisations and guide them on applying for these funding programs. By doing so, the synergy between various players can be stimulated, and an innovative posture of organisations can be motivated to achieve greater innovation performance.

Although Kazakhstan, Azerbaijan, Iran, and Algeria have greater GDP volumes than most of the other analysed countries, the rankings of these countries from the innovation performance index created by WIPO and from the results of this paper are lower than those of the others. For this reason, these countries need to place more emphasis on innovation activities, create greater volumes of budgets for R&D, provide more credits for enterprises, stimulate patent and certification applications and other innovative activities. Doing so can improve their innovation performance and financial and economic development.

Although this paper uses different MCDM methods, integrates them, includes different countries from different continents and analyses values over a long time, it has some limitations. The first limitation is that the findings and rankings might differ depending on MCDM methods. This fact has already been shown in the paper. Some studies using different MCDM have already found different rankings. This fact is a common issue when using MCDM methods. To overcome this limitation, further studies can include various MCDM methods in their analyses. They can implement various criteria weighting approaches to provide a general overview of countries' innovation performance rankings. The methods that researchers can apply might be CILOS, LBWA, LMAW, MEREC as weighting methods, and TODIM, MCRAT, MABAC, PARIS as ranking methods and various integrations of them, since these methods are relatively novel and proper to make quality papers when making cross-country comparisons. Moreover, researchers can focus on an income level and include various countries with different income levels to make more detailed comparisons. Researchers can also compare different periods, such as before the COVID-19 pandemic and after the COVID-19 pandemic, to represent the impact of some crucial issues on countries' innovation performance and rankings.

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